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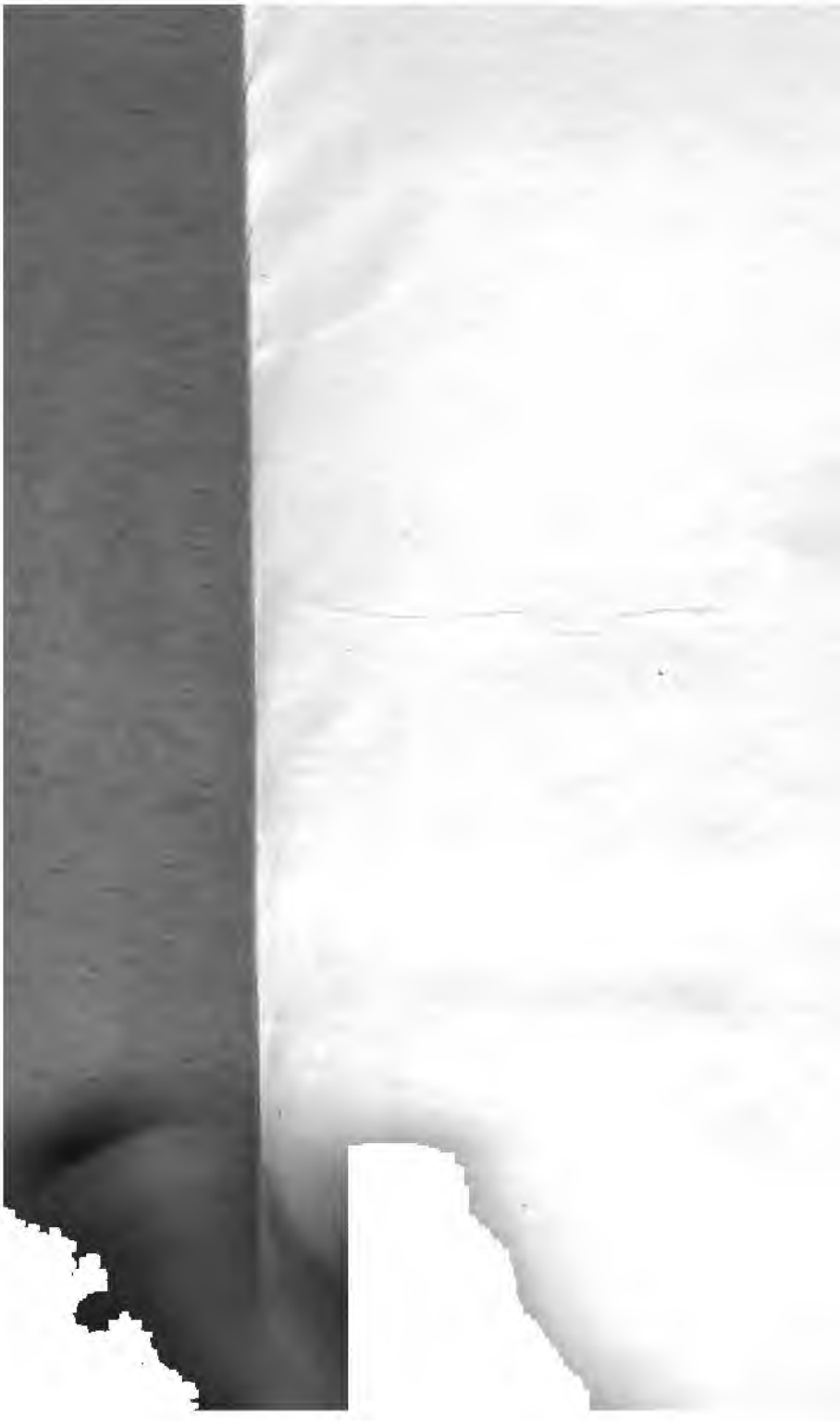

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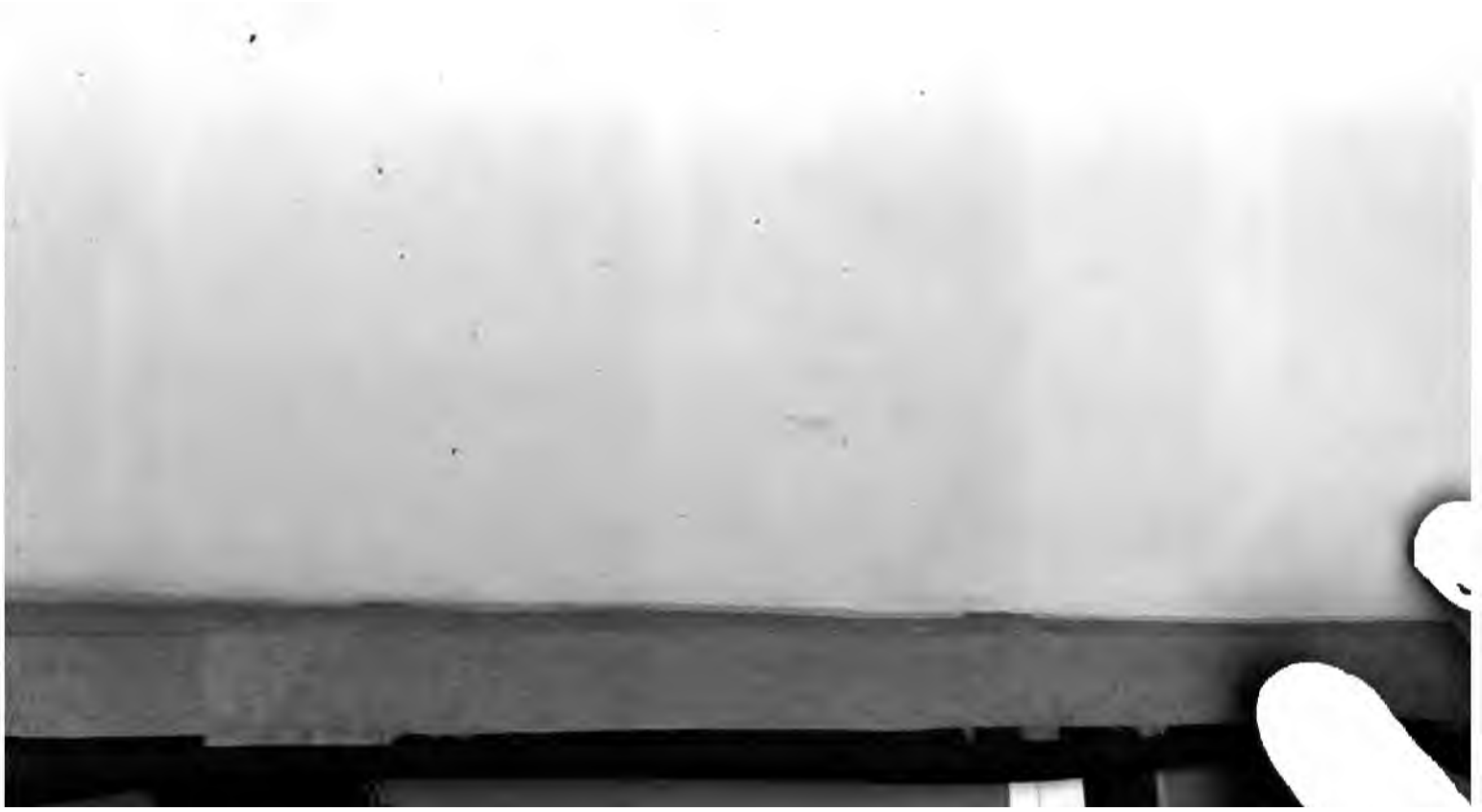

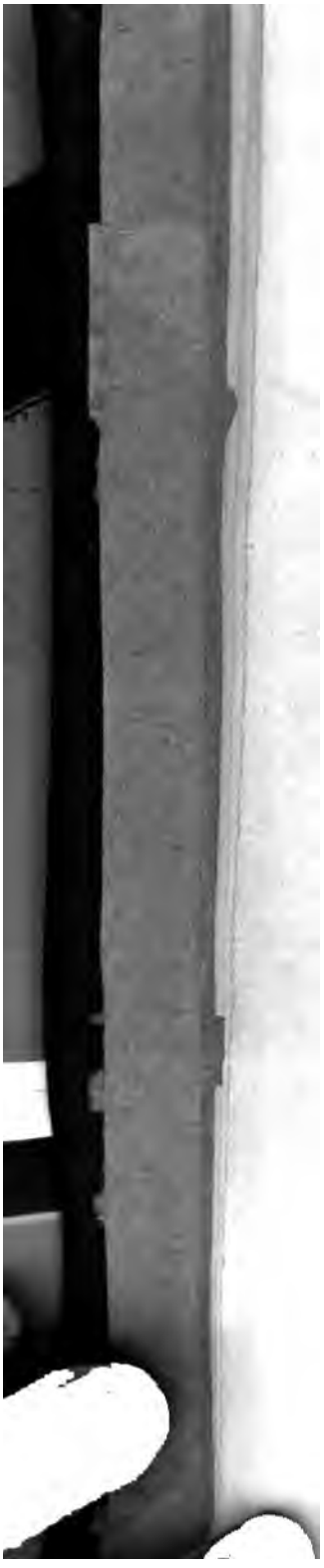

From a drawing by J. Wolf.]

HEAD AND FORE-LIMBS OF THE

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MADAGASCAR.

[*Frontispiece.*

MOSTLY MAMM.

Zoological Essays

BY

R. LYDEKKER

WITH SIXTEEN
FULL-PAGE ILLUSTRATIONS
BY
THE DUCHESS OF BEDFORD, LORD DELAM
THE HON. WALTER ROTHSCHILD
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PREFACE

THE whole of the articles collect volume have previously appeared ical literature; the great majority in but others in *Nature*, the *Field*, and To the editors of these journals the Auth returns his best thanks for the kind to reproduce the articles in their pres special thanks being due to Messrs. the publishers of *Knowledge*, for the loa of the original illustrations.

The importance of "nature study," n so much to the fore, is strongly insiste several of the articles.

In a few instances two or more ar been combined, but for the most part th produced as much as possible in their ori with such alterations as have been found in order to bring them up to date, a

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few omissions to avoid unnecessary repetiti
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found to exist, as somewhat similar ground
certain instances, traversed in the course
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total omission of others; and it was conse
decided to print the entire series almo
stood.

HARPENDEN LODGE, HERTS,
April 5th, 1903.

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PART I

MOSTLY MAMMALS

ANIMALS EXTERMINATED DURING THE NINETEENTH CENTURY

WHILE the century which has lately closed may fairly lay claim to the gratitude of posterity on account of the magnificent tale of zoological work accomplished during its course, it is, on the other hand, undoubtedly open to the charge of having permitted the total extermination of not a few animals, and of having allowed the numbers of others to be so reduced that their disappearance, at least as truly wild creatures, can scarcely be delayed very many years longer. Possibly, if not probably, the sweeping away of the enormous herds of many species, like those of the American bison, may have been an inevitable accompaniment of the march of civilisation and progress; but there is no sort of excuse to be made for the fact that in certain instances naturalists failed to realise that species were on the very verge of extermination, and that they were actually allowed to disappear from the world without being adequately represented in our museums. Nor is it by any means certain that even the present generation is altogether free from reproach in this matter, for although it cannot be said that any species hovering on the verge of extermination are absolutely unrepresented in collections,

yet whether, sufficient specimens of such species are being preserved for our successors may be an open question.

It is not my intention in this article to allude to the hosts of animals whose numbers have been reduced in such a wholesale manner during the century as to render them in more or less immediate danger of impending extermination, but to confine our attention in the main to those on whom this fate has already fallen. And here it may be mentioned with satisfaction that India enjoys a remarkably good record in this respect, for, so far as we are aware, it has not lost a single species of mammal, bird, or reptile, either during the nineteenth century or within the period of definite history. It is true that the numbers and range of the Indian lion have been sadly curtailed during the last fifty years, and that if steps are not promptly taken for its protection that animal may long disappear from the Indian fauna. But, at any it has not done so at present; and even were it terminated in that country, this would not mean extinction of a species, and possibly not even of a race, since it is not improbable that the Persian rep tative of the lion (which is still abundant) may distinguishable from the Indian animal. Of large a peculiar to India, perhaps the great Indian rhinocero one that requires most careful watching in order numbers and its range may not be unduly reduce it is too late to take adequate measures for its protec

We have said that the century is responsible extinction of no inconsiderable number of the animals. But it must not for one moment be that, within the historic period, no such extermi human agency had taken place in previous cent

have to go back so far as the year 1615 for the last evidence of the existence, in a living state, of the great flightless rail (*Aphanapteryx*) of Mauritius and Rodriguez; while the journal of the mate of the *Berkeley Castle*, in 1681, is the last record of the dodo being seen alive. Again, the tall and flightless solitaire of Rodriguez is not definitely known to have been met with by Europeans after 1691, although there is some evidence to indicate that it may have lingered on in the more unfrequented portions of the island till as late as 1761. Of the extinct géant, or Mauritian coot (*Leguatia*), we have no evidence of its existence subsequent to 1695; while our last record of the crested parrot (*Lophopsittacus*) is as far back as 1601. The great northern sea-cow (*Rhytina gigas*), which was only discovered on the islands of the Bering Sea in the year 1741, had entirely ceased to exist by about 1767. Moreover, the giant tortoise of Réunion appears to have become extinct in its native island previous to the dawn of the nineteenth century, as was probably the case with some of the other species formerly inhabiting the islands of the Indian Ocean.*

Neither can the nineteenth century be held responsible for the extermination of the South African blaauwbok (*Hippotragus leucophaeus*), a smaller relative of the roan antelope, since the last known example is believed to have been killed in or about the year 1799. It had always a curiously restricted habitat, being confined to a small area in the Swellendam district.

On the other hand, the great auk is a bird whose loss we owe to the carelessness of the naturalists of the middle of the nineteenth century, for there is little doubt that if protective measures had been taken in time, it might have been alive at the present day. From the American side

* See the article in the sequel on "Giant Land-Tortoises.

of the Atlantic it probably disappeared somewhere about the year 1840; while the summer of 1844 witnessed the destruction of the last European pair of this remarkable bird, the last British representative of the species having been hunted to death in the neighbourhood of Waterford Harbour ten years previously.

One of the most sad storiesof extermination, and that, too, at a comparatively recent date, is revealed in the case of the South African quagga. Since a full account of the species is given in a later article, it will suffice to state here that in Cape Colony the extermination apparently took place about the year 1865, although the species may have survived a few years longer in the Orange River Colony, which was the last stronghold of the species.

Mention has already been made of the extermination of the giant land-tortoise of Réunion during the eighteenth century; and in the early part of its successor four other species became extinct in the neighbouring islands of the Mascarene group—namely, *Testudo indica*, *T. triserrata*, and *T. inepta* in Mauritius, and *T. vosmaeri* in Rodriguez. It has likewise been considered probable that the thin-shelled tortoise (*T. abingdoni*) of Abingdon Island, in the Galapagos group, is also no longer existing, although it was certainly alive as recently as 1875.

Of birds that have disappeared during the century, in addition to the great auk, reference may first be made t the black emeu (*Dromaeus ater*) of Kangaroo Island, Sout Australia. When this island was explored in 1803 by French expedition, these birds were abundant, and thre were sent home to Paris, where a pair lived till 1822. their death, the skin of one and the skeleton of the o were mounted for exhibition in the Paris Museum, wl they still remain. Of the third specimen no record

obtainable till 1900, when its skeleton was discovered by Prof. Giglioli in the museum at Florence. These three priceless specimens are the only examples of a species which became extinct in the native state previous to the death of the Paris pair, and before it was even known to be different from the larger emeu of the mainland. For it appears that some years after the visit of the French expedition (to which Péron was naturalist) to Kangaroo Island, a settler squatted there and forthwith set to work to make a clean sweep of the emeus and kangaroos—a task in which he was only too successful.

Before the middle of the century another large bird appears to have made its final exit from this world. When Steller discovered the northern sea-cow in the islands of Bering Sea, he also brought to the notice of science a new species of cormorant (*Phalacrocorax perspicillatus*), which was especially interesting on account of being the largest representative of its kind, and likewise by the bare white rings round its eyes and the brilliant lustre of its green and purple plumage. Stupid and sluggish in disposition, Pallas's cormorant, as the species is commonly called, appears to have been last seen alive about the year 1839, when Captain Belcher, of H.M.S. *Sulphur*, was presented with a specimen by the Governor of Sitka, who also forwarded other examples to St. Petersburg. Captain Belcher's specimen is preserved in the British Museum, and three other skins are known to be in existence elsewhere.

The great white water-hen (*Notornis albus*), formerly inhabiting Lord Howe and Norfolk Islands, must be added to the defunct list. And the same is the case with the Tahiti white-winged sandpiper, or rail (*Hypotoenidia pacifica*), which in Captain Cook's time was abundant in the island

from which it takes its name, as well as in the neighbouring Eimeo. The New Zealand quail (*Coturnix novae-zealandiae*) is likewise entered in the British Museum as extinct. The beautiful "*Pigeon hollondais*," so called from its plumage presenting the Dutch colours, and technically known as *Alectroenas nitidissima*, is a Mauritian species whose extermination probably took place during the century. It is known solely by three examples, one of which is preserved at Port Louis, the second in Paris, and the third in Edinburgh.

Nor must we omit from our list two species of Kaka parrot, one of which (*Nestor productus*) was a native of Philip Island, while the home of the second (*N. norfolcensis*) was the neighbouring Norfolk Island. A species of paraquet (*Palaeornis exsul*), peculiar to the island of Rodriguez, is also believed to be exterminated.

Neither has the duck family escaped, for the well-known pied duck (*Camptolaemus labradorius*), an ally of the eider from the North Atlantic coast of America, appears in the defaulters' list, the last known example having been killed in 1852.

Passing on to Passerine birds, a notable loss is the handsome crested pied starling (*Fregilupus varius*), of Réunion, believed to have become extinct about the middle of the century. Of the few remaining examples of this striking species, one is preserved in the British Museum. Another species, exterminated within approximately the same period, is the gorgeous black and gold mamo, or sicklebill (*Drepanis pacifica*) of Hawaii, whence it was first brought to Europe by Captain Cook. As narrated in the "Birds of the Sandwich Islands," by Messrs. Scott Wilson and Evans, the extermination of this beautiful species is to be attributed to persecution for the sake of its yellow feathers, which

were used for the cloaks of the native chiefs. About four specimens are known to be preserved in museums.

Of birds that have been locally exterminated, such as the burrowing petrel (*Oestrelata haesitata*), known in the Antilles as the diablotin, it is not our intention to speak on this occasion. This article may accordingly be fitly brought to a close by an extract from Prof. A. Newton's "Dictionary of Birds," referring to two instances where species may have perished within the century without having ever come definitely under the notice of ornithologists. After stating that one Ledru accompanied an expedition dispatched by the French Government in 1796 to the West Indies, the Professor proceeds to observe that this explorer "gives a list of the birds he found in the islands of St. Thomas and St. Croix. He enumerates fourteen kinds of birds as having occurred to him then. Of these there is now no trace of eight of the number; and, if he is to be believed, it must be supposed that within fifty or sixty years of his having been assured of their existence they have become extinct. . . . If this be not enough, we may cite the case of the French islands of Guadeloupe and Martinique, in which, according to M. Guyon, there were once found six species of Psittaci, all now exterminated; and it may possibly be that the macaws, stated by Messrs. Gosse and March to have formerly frequented certain parts of Jamaica, but not apparently noticed there for many years, have fallen victims to colonisation and its consequences."

THE COLORATION OF LARGE ANIMALS

To the more observant class of sportsmen the stay-at-home naturalist is, of necessity, indebted for most of his information with regard to the habits of large animals and their adaptation to their inanimate environment. And it must be acknowledged that, in the main, he has but little cause of complaint as to the accuracy, fulness, and abundance of the information thus supplied. One subject, and that a very interesting and important one, in connection with large animals in the field, seems, however, to have attracted but a small share of attention on the part of sportsmen and travellers, although it is obvious that whatever theories and conclusions the naturalist may draw from the study of museum specimens must be put to the test by observations in the field before they can be regarded as of any definite and established value. I refer to the connection between the different types of coloration of the larger animals and their natural surroundings. Apart from casual remarks with regard to the harmony existing between the dappled coloration of a South African giraffe and the splashes of light and shade in the mimosa groves it inhabits, the resemblance presented by a tiger's stripes to the dead grass of the surrounding jungle, and such-like, I can recall scarcely a single observation recorded by sportsmen or travellers which is of any real scientific value in connection with the subject in question. One important

exception—namely, the observation made several years ago that zebras standing on the open veldt in bright moonlight are practically invisible at a short distance—must, however, be made to this sweeping assertion. And it is scarcely too much to say that this important observation—which applies also, I believe, to a considerable extent to the same animals in daylight—has formed the starting-point of modern ideas with regard to the purport and meaning of many types of mammalian coloration.

Before alluding in detail to these ideas and theories, in order to show what has been done and what remains to be done in this line of research, it may be well to point out that, with the aforesaid exception of the zebras, practically all our conclusions with regard to the purport of the coloration of most of the larger mammals have been drawn from the examination of stuffed specimens or skins, supplemented by observations upon domesticated animals, or species living in a semi-domesticated state in parks or zoological gardens. With regard to foreign species kept in parks or menageries, the observations are not, in most cases, of any real value, on account of the circumstances that the animals are living under changed conditions, and not amid their natural surroundings. When skins are once deposited in a museum the naturalist has no means whatever of ascertaining by actual experiment how their coloration harmonises, or otherwise, with their natural environment, all that he can do being to glean as much as possible with regard to the latter from the accounts of eye-witnesses, and to draw his conclusions accordingly. Something might doubtless be done if it were permissible to take the skins into the woods and open country and test their conspicuousness or invisibility by experiment; but even such experiments cannot, in most cases at any

rate, be conducted with museum specimens; and, if practicable, they would, at the best, give us but a poor inkling of the real truth. What we want are precise and accurate observations made on living animals with regard to the harmony between their colours and their surroundings; and such observations can only be made by sportsmen and travellers, and more especially by the former. And to be of any real value such observations must be made under all conditions: in the case of a forest animal, for instance, both when the creature is in the woods and when out feeding in the open. Nor is this all, for it is necessary to ascertain what portions of an animal's coloration are adapted to render the body inconspicuous under all circumstances—such as the white of the under-parts to counteract the effect of shadow—and what portions have been developed in correlation with the particular natural surroundings of a species or group. Then, again, we have to distinguish between protective coloration and what are known as "recognition marks," such as the white under-surface of the tail of a rabbit. Furthermore, there is the distinction between both these types and the so-called "warning colours," like the black and white of the skunks, which are apparently intended to render their owners conspicuous, and thus protect them from attack, either on account of some noxious emanation they possess or from their fighting power. These warning colours are, however, comparatively rare among mammals; and observation is mainly required in regard to protective coloration, especially when some species of a group are brilliantly spotted or striped, while others are uniformly clad in a less gorgeous livery.

Speaking generally, and excepting certain unusually bulky kinds, such as elephants, rhinoceroses, and hippo-

potamuses, it is fairly safe to assert that among the medium-sized and larger mammals the primitive type of coloration took the form of either striping or spotting. This is demonstrated by the many known instances there are of the young being striped or spotted, while the adults are more or less uniformly coloured. As well-known examples of this kind we may cite tapirs, wild swine, many kinds of deer, lions, and pumas. In many cases the substitution of a uniform dull livery for a spotted or striped coat has evidently been in adaptation to an existence in open or desert country. Instances of this kind are afforded by the lion and the Cape eland, the latter of which has lost the stripes characteristic of its more northern representative and of the kindred antelopes such as the kudus and bushbucks.

The fact that the young of certain animals haunting more or less arid districts, such as the lion, still retain their spots, while others, like the eland, differ from their relatives inhabiting more wooded country only by the loss of their stripes, indicates that in these cases, at any rate, the acquisition of a uniformly coloured tawny coat is a comparatively recent event. Possibly an explanation of this may be afforded by the history of deserts and semi-deserts themselves. In contradistinction to the old idea that they are ancient upraised sea-beds, it is now well known that all desert areas have been formed very slowly by the gradual decomposition of the rocks in countries where there is no rain to wash away the *débris*. And it seems by no means improbable—owing to the enormous lapse of time necessary for their formation, coupled, perhaps, with a greater rainfall over most parts of the world in earlier epochs—that such tracts never existed until late in the earth's history.

Be this as it may, we have no sort of difficulty in realising why many desert-haunting animals have exchanged a striped or spotted coat for one of which the colour is manifestly in harmony with the natural surroundings. Our real difficulties occur in the cases where animals have a very similar kind of habitat, but display a total difference in their type of coloration. Why, for instance, have many kinds of deer—notably the Indian sambar and its kindred—discarded their original spotted dress for one of a sombre brown or red, while others, like the chital (at all seasons) and the fallow-deer (in summer), have retained the primitive dress? Or why, again, are the African bushbucks and kudus, which are as much forest animals as the sambar, some of the most brilliantly coloured of all hoofed animals? If a variegated and brilliantly coloured coat is essential to the well-being of these animals, why is it not equally essential to the sambar, or *vice versa*? It is in regard to questions like these that naturalists want help and assistance from sportsmen and travellers, for at present they are working to a great extent in the dark owing to lack of definite and accurate observations in regard to the relation of the colouring of these and other mammals to their surroundings.

In spite, however, of our ignorance of the reason why some forest animals should be uniformly dark-coloured while others are more or less brilliantly striped, the conclusion is being gradually forced upon us that in both cases protection is the object. Apparently, as pointed out in the sequel, the true explanation is that the spotted and striped species inhabit bush, or the more open parts of the forest, while dusky species like the sambar frequent dense thickets, as, indeed, Sir Samuel Baker states, is the habit of the

latter animal in Ceylon. Moreover, spotted species seem to be more essentially diurnal than sombre-coloured forms.

When the meaning and purport of the coloration of mammals first began to receive careful attention on the part of naturalists, there was a tendency to classify brilliant markings like those of the African bushbucks, bongo, and kudus as "recognition markings"—that is to say, markings designed to enable all members of a species to recognise with facility their own kind. Animals have, however, other modes of mutual recognition in addition to colour; besides which different species, whether they go about in pairs, in small family parties, or in herds, keep, as a rule, more or less to themselves, and are in no danger of mistaking other species for their own kind. Probably among the great majority of mammals the only "recognition marks" are the white or light-coloured areas on the tail or hindquarters, which are displayed to their fullest extent in many cases when the members of a party or herd have to "bolt" suddenly to covert. In some species, like the rabbit and the white-tailed American deer, the white area is restricted to the under-side of the tail and the adjacent portions of the buttocks, and in such cases the tail is always raised when in flight, so as to expose a large and conspicuous blaze of white. In other species, such as the Japanese deer and its relatives of the Asiatic mainland, or the roe, the white area takes the form of a patch of long hairs on the rump, which are erected and expanded when the animals are alarmed. Probably the straw-coloured rump-patch of the wapiti and red-deer is of the same nature, but as these animals are less likely to miss their leader when in flight than is the case with smaller species, the "recognition mark" is less conspicuous.

In regard to spotted deer and striped antelopes, it

seems probable, as has been suggested by Mr. R. I. Pocock in an article published a couple of years ago in *Nature*, that the white markings belong to two different categories so far as their purpose is concerned. In many of such animals not only is the under-surface of the body white, but there are several white gorgets on the throat and white spots on the side of the face and chin. Now there can be little doubt that such white areas are for the purpose of counteracting the dark shade thrown by the body, and thus rendering the animal much less conspicuous when seen at a distance than would otherwise be the case. That this is the true explanation is rendered practically certain by the circumstance that such white markings, especially the gorgets on the throat, persist in species which, like the Indian nilgai and the American prongbuck, have lost the ancestral stripes and spots. In neither of the two species referred to, it may be well to observe, are the young spotted or striped, and it is therefore only from analogy that we speak of their ancestors being thus coloured; but the nilgai is so closely related to the bush-bucks and kudus that there can be little doubt that the assertion is justifiable. Even, however, if it were not so, the case as regards the purport of the white gorgets and under-parts remains unaltered. It may be added that such white patches can only be effectual where there is plenty of light to throw the shadow; and this is in accordance with the fact that kudu and chital inhabit less dense forest than sambar.

Having indicated, then, the special purpose of the white under-parts and throat-markings of deer and antelopes, we may consider the object of the stripes and spots characteristic of certain species and groups. All the bushbucks, save the males of one or two species, together with their

near relatives the bongo, the kudu, and the elands, are characterised, as a rule, by having the whole body marked by narrow white stripes, which are, for the most part, vertical (although in some cases they form a kind of network) upon a fawn or rufous ground. And these animals, as is attested by the large size of their ears, are chiefly dwellers in forest. Directly, however, any member of the group has left the forest for more open country, as in the case of the Cape eland and the Cape bushbuck, the stripes more or less gradually disappear. Further, those species which inhabit the densest forest have their colours the most brilliantly developed, as is well exemplified in the case of the lesser and the greater kudu, the former of which is more of a forest animal than the latter. One of the most brilliantly coloured of all is the bongo of the equatorial forests.

Clearly, then, narrow vertical white stripes on a fawn or chestnut ground, which we have reason to regard as a very primitive type of animal coloration, are connected with a forest life, and the presumption is that they are of a protective nature. Confirmation of this view—if confirmation be needed—is afforded by two animals belonging to widely different groups—namely, Grévy's zebra and the Somali giraffe. The former of these animals differs from all its kindred by its enormous and heavily fringed ears, and these proclaim it to be a dweller in brushwood or forest rather than in open plains, a supposition which receives definite confirmation by the photographs taken during Lord Delamere's East African journey. But Grévy's zebra likewise differs from all its kindred by the extreme narrowness of its stripes, white stripes alternating with black ones of the same width. Here, then, narrow white stripes are clearly an adaptation to a forest life. And

we further learn, from contrast with the bushbucks, that when the ground-colour is fawn or rufous the intervals between the white stripes must be large, while in the case of a black ground such intervals are no greater than the width of the stripes. Whether such modifications of the pattern according to the shade of the ground-colour produce the same effect in forest or brushwood, can be learnt only by actual observation, and here again we must look to the sportsman.

As regards the Somali giraffe, those who have had the opportunity of seeing Lord Delamere's photographs can scarcely fail to notice that the type of coloration differs markedly from that of the common species, while the animal itself appears to be found in much more jungly country than is the case with the former. In place of having a buff ground-colour blotched with large irregular chocolate patches, the Somali giraffe is a liver-coloured animal marked with a coarse network of fine white lines, the type of coloration coming very close to that of some of the smaller bushbucks. Clearly this colouring is an adaptation for a mode of life not very different from that of the bushbucks, whereas the coloration of the ordinary giraffe is suited to an animal dwelling in open plains dotted here and there with tall scattered trees. The two types of coloration are, in fact, precisely analogous to those of Grévy's zebra as compared with Burchell's zebra, the one being a dweller in brushwood and the other in open country. The Somali giraffe has not, however, acquired the broad ears of essentially forest animals like its cousin the okapi, and for a very sufficient reason. The brushwood amid which this giraffe is commonly found does not reach more than half-way up its neck, as is clearly shown in the photographs already alluded to, so

[From a photograph by Lord Delamere.]

EAST AFRICAN GIRAFFES IN COVERT.

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that ears of ordinary size suffice for the creature's hearing.

The mention of the okapi recalls the fact that the coloration of the upper part of the legs and hindquarters takes the form of narrow black and white stripes, running, however, more horizontally than vertically, but evidently conforming to the characteristic forest type. To attempt to discuss why the coloration of the rest of this remarkable animal is uniform would be premature in the absence of any definite information with regard to its mode of life.

From the foregoing observations it seems evident that in Africa, and in that country alone (for there are no vertically striped ungulates in Asia), there are two distinct types of protective coloration, the one generally associated with large ears, for animals frequenting forest or brushwood, and the other for those living in more open country. The forest type takes the form of white stripes, either upon a fawn or chestnut or upon a black ground (the dark intervals being broad in the former case and narrow in the latter), or of a white network upon a liver-coloured ground. On the other hand, in the plain type we have either an alternation of broad dark and light vertical stripes or dark blotches upon a buff ground. Both forms of the latter type have been definitely stated to render the animals in which they occur more or less inconspicuous at comparatively short distances. But, so far as I am aware, there are absolutely no observations to indicate the degree of invisibility in the wild state of the two modifications of the forest type. Probably, however, the alternations of dark and light vertical stripes harmonise with the vertical lines formed by stems of underwood and the spaces between them.

We also want to know whether either or both of these

types of apparently protective coloration are for their special purpose as good as (or better than) a uniform coloration, or under what circumstances, if any, the latter is superior to the former. For, curiously enough, both the forest and the plain type of coloration appear to have been transformed, in some instances, into a uniformly coloured coat. As regards the plain type, the now extinct quagga shows the partial loss of the stripes, which have completely disappeared from the wild asses of Northern Africa. Very remarkable is the circumstance that from a fully striped animal like the so-called Grant's zebra of Abyssinia there is a complete graduation to the typical Burchell's zebra of the Transvaal, in which the stripes have disappeared from the legs, and the dark stripes are intercalated with paler "shadow stripes." One step from this animal and we reach the quagga, which, be it noted, inhabited the same country as the uniformly coloured Cape eland. Evidently in the Cape district both the forest and the plain types of striping were unsuitable and tended to disappear. In the North African wild asses the disappearance of the striping is complete. Before we can attempt to explain this it is necessary to know whether a Grant's zebra and a wild ass are equally inconspicuous in their own particular habitats, and whether any difference in this respect would be noticeable if the one were transported to the habitat of the other.

An instance of the replacement of the forest type of striping by a uniform coat (otherwise than in the case of a desert-dwelling species) is afforded among the bushbucks by the males of the nyala, which have long, shaggy brown coats with but very indistinct traces of striping. Is this dark coat a better protection than the brilliantly striped one of the female, or is it assumed because the males

have (on account of their horns) no longer any need of protection? On the other hand, is it due to the fact that the bucks keep more to the heart of the forest, and are more nocturnal than their partners?

Another phase of coloration for the development of which no satisfactory reason can be assigned is presented by the males of certain ruminants, such as the Indian blackbuck, the white-eared kob, and Mrs. Gray's kob of the White Nile, and the banting, or wild ox, of Java. In all these four species (the first three of which are antelopes) the adult males exchange the foxy red coat of the younger members of their own sex and of the females at all ages for a sable livery relieved by larger or smaller white areas. Clearly this coloration, in place of being protective, renders the animals in which it occurs conspicuous. The only suggestion which seems at all reasonable is that it must either be a "warning colour" or one adapted to attract females towards the leader of the herd. If it come under the former category, it has apparently been developed in order to deter other animals from attacking the leaders of the herd, on account of their prowess in fight. That such an immunity would be an advantage to the individuals in question cannot be doubted; and possibly it receives support from the circumstance referred to in the next paragraph.

Although both sexes of the banting carry horns, the females of the aforesaid three species of antelope are hornless. In certain species, such as the sable antelope of Africa and the gaur (the miscalled bison) of India, in which both sexes are horned, the adult females as well as the males have assumed a blackish coat; and, so far as it goes, this phase is in favour of the view that the acquisition of a sable livery by certain species is for the

purpose of warning off foes, both sexes in the above instances having formidable weapons of offence and defence, and being thus perfectly capable of taking care of themselves.

Probably the black hue of the Asiatic buffaloes and of the typical race of their African relatives was originally developed in the same manner and for the same purpose as in the case of the sable antelope. It may, however, now have acquired a higher significance, and be connected with the general prevalence of blackness among large hoofed mammals, such as elephants, rhinoceroses, hippopotamuses, buffaloes, and, to a great extent, tapirs. Among such animals it will not fail to be noticed that in many instances both sexes are armed with either horns or tusks; and that where such weapons have been discarded the animals are sufficiently protected either by their huge bodily bulk or by the nature of their haunts. Although we have the testimony of many sportsmen as to the difficulty of seeing an Indian elephant, even at close quarters, when in thick covert, we have yet to learn whether the prevalence of a black or dark grey skin among so many of the larger mammals is or is not for the purpose of protection. But since large herds of animals thus coloured are frequently to be met with in open country, it has probably been developed for some other purpose, although what this may be it is difficult even to conjecture.

Returning once more to deer, and taking first the case of the fallow-deer, which (with the exception of the dark race) is spotted in summer and uniformly coloured in winter, there seems no doubt that the dappled summer coat is for the purpose of harmonising with the chequered shade cast by the leafy boughs of the trees under which the animals are wont to repose. This harmony has doubtless been noticed by many of my readers, and is well expressed

in the following passage from Dr. L. Robinson's "Wild Traits in Tame Animals," which refers to a scene in Greenwich Park :—

"The dappled fallow-deer were grazing among the chestnut-trees or lying down upon the soft grass. I sat down on a seat to watch them, determined, if possible, to learn something fresh from them before I moved from the spot. One could not help noticing how remarkably their mottled skins, angular outlines, and branching horns fitted them for concealment in the glades of the forest. Even here, where the surroundings were to a large extent artificial, every now and then the eye would suddenly chance upon a deer resting among the chequered shadows, which was so inconspicuous that it had previously escaped notice."

Assuming, then, that the object of the dappled coat is to harmonise with the splashes of sunlight and shade beneath forest trees in summer, it is perfectly obvious that in temperate latitudes such a type of coloration would be quite out of place in winter, when the forest trees have shed their leaves. Accordingly the fallow-deer exchanges its dappled summer livery for a uniform coat of fawn more in harmony with the sombre colour prevalent in nature generally during the northern winter. A precisely similar change takes place in the Japanese deer and its relative, the Peking deer of Manchuria, both of which have bright chestnut coats dappled with large white spots in summer, while in winter they are clothed in sombre brown. It is, moreover, noticeable that in the Peking deer the summer coat is exchanged for the winter dress comparatively early in the season—doubtless in correlation with the early advent of winter in its native habitat.

The Japanese and Peking deer have, however, a repre-

the primitive spotted coloration of the chital for a dull brown and shaggy coat are proclaimed to be essentially animals of the thick forest by the large size of their ears, although this characteristic is more strongly marked in the larger than in the smaller races of the group. Dr. Blanford's account of the habits of the Indian sambar runs as follows:—

"This is the woodland deer of South-Eastern Asia generally, and is more widely and generally distributed than any other species. . . . It comes out on the grass slopes when such exist, as in the Nilgiris and other hill-ranges, to graze, but always takes refuge in the woods. It is but rarely found associating in any numbers; both stags and hinds are often found singly, but small herds of four or five to a dozen in number are commonly met with. Its habits are nocturnal; it may be seen feeding in the morning and evening, but it grazes chiefly at night, and at that time often visits small patches of cultivation in the half-cleared tracts, returning for the day to wilder parts, and often ascending hills to make a lair in grass amongst trees, where it generally selects a spot well shaded from the sun's rays."

Contrasting this with the account given above of the mode of life of the chital, the reason of the colour of the sambar will be apparent. It is essentially a deer of the thickets, nocturnal and more or less solitary in habits, and shunning the sunlit glades. Hence not only is the coat uniformly dusky brown, but the white "recognition marks" on the rump, so useful in the case of the fallow-deer and the sikas, are entirely wanting.

As regards the change from a grey fawn-colour in summer to a foxy red in winter exhibited by many kinds of deer —most markedly by the American white-tail and the European roe, and, in a somewhat less degree, by the

red-deer—it seems to be certainly analogous to the change from a spotted to a uniform coat in the Japanese and fallow-deer, and must therefore be for the purpose of protection. *Prima facie*, it might have been thought that the winter dress would be red, since this tint would apparently harmonise well with the russet hue of fallen leaves and dead bracken. The tone of the summer dress is, however, very similar to the ground-colour of the coat of the Peking and Japanese deer at the same season, although we have yet to learn why a uniformly red tint is more advantageous in the case of the roe and the white-tail than a spotted dress. Possibly it may be owing to the more open nature of the country frequented by these and other species in which this type of coloration prevails.

That the change in the roe, the red-deer, and the white-tailed deer from red in summer to grey in winter is analogous to the change from a spotted to a uniform coat in the Peking deer and the fallow-deer, is demonstrated not only by the nature of the colour itself, but more emphatically by the circumstance that in tropical and subtropical countries red-coated deer, such as the Indian muntjac and swamp-deer, or barasingha, retain their colour throughout the year. A similar condition is noticeable in the case of the small tropical representatives of the Virginian white-tailed deer, most or all of which do not change their colour with the season. In the last-mentioned instance it appears, indeed, that the coat is brownish or greyish, instead of red; but this may be connected with the tendency to melanism, so often noticeable in the case of animals inhabiting moist tropical forests. Be this as it may, it is quite clear that the change from a red summer coat to a grey winter dress in species like the white-tail and the roe is for the purpose of protection,

and is correlated with the presence of foliage on the trees at the one season and its absence at the other. It may be added that the white-tail and the muntjac have the under-side of the tail and the inner surfaces of the buttocks white, and thus display a conspicuous patch when running to covert with the tail elevated. Somewhat curiously, the roe generally develops a white rump-patch only when in the grey winter dress.

Although the reason for many details remains to be worked out—and for this naturalists must rely on the good offices of sportsmen—I venture to think that the foregoing theory affords a satisfactory explanation of most of the different types of coloration prevailing among the deer. Probably the coloration of the chital—spotted at all seasons—was the primitive type. From this was evolved the seasonal change characteristic of the fallow and Peking deer, and from this, again, the absence of spots at all seasons distinctive of the white-tail and roe. A further specialisation is displayed in the tropics by the sambar in one direction and the muntjac and barasingha in the other. If these conclusions be well founded, it is evident that deer were originally a tropical group. It should be mentioned that the Indian hog-deer, which develops spots in summer, is an exception to the rule that tropical deer, if spotted at all, retain their markings all the year.

The foregoing summary of the extent of our knowledge—or, rather, of the depth of our ignorance—with regard to the meaning and object of the different types of coloration prevalent among the larger mammals may, it is to be hoped, direct the attention of travellers and sportsmen to an extremely interesting, but much neglected, subject, and thus lead to a real advance being made in the interpretation of the facts.

SPOTS AND STRIPES IN MAMMALS

SUCH of my readers as have considered the subject at all may be aware that in those animals whose fur is ornamented with dark or light markings, these markings generally take the form either of longitudinal or transverse bands, or of spots; the latter being frequently arranged in more or less distinctly defined longitudinal lines, but never in transverse bands. Moreover, these markings, especially in the case of stripes and bands, are generally most developed on the upper surface of the body, although spots may be equally present on both the upper and the lower surfaces of the body. Many mammals, again, whether they be spotted or whether they be striped, have their tails marked by dark rings on a light ground; but this feature is also present in others in which the colour of the body is of a uniform tint. It must not, however, be supposed that there is any sharply defined distinction between spotted and striped mammals, many of the civets, as well as some of the cats, having markings intermediate between true spots and stripes. Spots, again, are somewhat variable in configuration, some animals, like the hunting-leopard, having solid circular dark spots, while in others, such as the leopard and jaguar, they assume the form of dark rings enclosing a light centre. In other cases, as in the giraffe, the spots are enlarged so as to form large and more or less quadrangular blotches.

A survey of a museum or a menagerie will likewise show that spots and stripes are by no means equally prevalent in all groups of mammals. In the apes, monkeys, marmosets, and lemurs, for instance, they never occur; and when these animals are diversely coloured, the coloration takes the form of patches symmetrically disposed on the two sides of the body, but otherwise not following any very clearly defined mode of arrangement. Then, again, in the hoofed mammals, or ungulates, many species are more or less uniformly coloured, although the zebras are notable instances of transversely striped animals, while the giraffe is an equally notable instance of the blotched type of coloration. Among the even-toed (*Artiodactyle*) subdivision of this order it may be also noticed that while in the more specialised forms, such as wild cattle and sheep, the coloration is more or less uniform, many of the antelopes show white transverse stripes on a dark ground. Dark transverse stripes are, however, known only in the case of the little zebra-antelope (*Cephalophus doriae*) of Western Africa, and the gnus; while, although a lateral dark flank-stripe is present in some antelopes, and in the gazelles, none of these animals have the whole body marked by longitudinal dark stripes. In the case of the deer it has been mentioned in the preceding article that certain species, like the fallow-deer and the Indian spotted deer, are marked with longitudinal rows of white spots at all ages; while in the case of other species it will be found that the young are similarly marked, whereas the adults are uniformly coloured. A similar state of things occurs among wild pigs, and also in the tapirs, from which we are naturally led to infer that in this group of mammals, at least, a spotted or striped type of coloration is the original or generalised condition, while a uniformly coloured

coat is an acquired or specialised feature. And the same holds good for other groups.

Turning to the carnivorous mammals, we find that in many families, more especially the cats, hyaenas, and civets, stripes and spots are far more generally present than a uniform coloration; although some groups, such as the bears, form a marked exception to this rule, the majority of the species being uniformly coloured, while none are striped or spotted. In some species of the weasel family—notably the badgers—it may be also noticed that while the sides of the head are marked by longitudinal dark and light stripes, the remainder of the body is uniformly coloured. And it may be mentioned here that many animals, such as donkeys and dun-coloured horses, retain a longitudinal dark stripe down the back, frequently accompanied by dark transverse bars on the limbs, while a uniform coloration prevails elsewhere.

In the gnawing mammals, or rodents, although many species are uniformly coloured, stripes and spots are prevalent; and a survey of the collection of these animals in a good museum will show that, whether the pattern take the form of stripes or of spots, the arrangement is invariably longitudinal and never transverse. Indeed, it may be observed that when spots are present, these are invariably light-coloured on a darker ground. Although in many cases the longitudinal stripes occupy the whole or a considerable portion of the upper surface, in some of the squirrels they are reduced to a dark and light stripe, or even a single light stripe on each flank, this remarkable type of coloration recalling the "speculum" on the wing of a duck.

I might extend this survey to other orders of mammals, but sufficient has been said to indicate the variability of

the prevalent type of coloration in different groups, and I accordingly proceed to give a list of some more or less well-known mammals arranged according to the plan of their markings.

1. *Mammals with dark longitudinal stripes.*—Striped mongooses (*Galidictis*) of Madagascar, in one of which the stripes are very narrow and close, while in the other they are broader and more widely separated; these animals belonging to the civet family. The three-striped palm-civet (*Arctogale*); the genet, the markings here tending to break up into spots; the three-striped opossum; the palm-squirrel, and chipmunks (*Tamias*).

In all the above the stripes are dark upon a greyish ground, but in the following they take the form of black and white stripes, the white area being generally the larger; and it may be noted that all belong to the weasel family. They include the skunks, the South African weasel (*Poecilogale*), and the Cape polecat (*Ictonyx*); while similar markings obtain on the head of the badger.

2. *Mammals with dark spots.*—These may be divided into several sub-groups, according to the form of the spots. Those in which the spots are small, more or less nearly circular, and solid, include the hunting-leopard, the tiger-cat, serval, lynx, spotted hyaena, large-spotted civet (*Viverra megaspila*), the African linsang (*Poiana*), and the young of the puma. The blotched genet (*Genetta tigrina*) forms a transition to blotches. Some of the civets are more or less distinctly spotted, in others the coloration is intermediate between spots and longitudinal stripes.

As species in which the spots are enlarged to form more or less quadrangular blotches, we may cite the common giraffe and those Oriental civets known as linsangs.

By a splitting-up of a certain spot into a more or less

complete ring of smaller ones, we have the rosette-like type of ornamentation, as exemplified in the leopard, the snow-leopard, and the jaguar. In the two former the ring encloses a uniform light area; but in the latter the central area generally carries two or more dark spots. A further development of the ring leads to the so-called clouded type, as displayed by the Oriental clouded leopard and marbled cat, and the American ocelot. Here the ring becomes enlarged into a large squarish or oblong area, enclosing an area of darker hue than the general ground-colour of the fur, and bordered by a narrow black line; the black line in the two former species being, however, confined to the hinder half of the cloudings.

3. *Mammals with dark transverse stripes.*—Tiger, young lions, wild cat, striped hyaena, aard-wolf (*Proteles*), banded civets (*Hemigale*), banded mongoose (*Crossarchus*), zebra-antelope, gnus, zebras, thylacine, and the water-opossum (*Chironectes*). Among these it may be noted that in the zebras the stripes on the hindquarters have a more or less marked longitudinal direction; and whereas in the mountain zebra and Grévy's zebra they consist of simple dark bands on a light ground, in some forms of Burchell's zebra the light areas between the dark stripes are traversed by an intermediate stripe of somewhat darker hue than the ground-colour.

4. *Mammals with white spots arranged in longitudinal lines.*—Fallow-deer and Indian spotted deer, young tapirs; the paca (*Coelogenys*) among the rodents; and the dasyures among the marsupials. Both in young tapirs and the paca the spots tend to coalesce into more or less complete longitudinal stripes.

5. *Mammals with white transverse bands.*—The kudu, eland, bongo (*Bŏocercus euryceros*), and harnessed antelope

(*Tragelaphus scriptus*) among the antelopes, and Gunn's bandicoot (*Perameles gunni*) and the banded ant-eater (*Myrmecobius*) among the marsupials. In the harnessed antelope spots occur as well as stripes.

Many other species might be incorporated in these lists, but the foregoing instances are sufficient to show that no one type of coloration is confined to any particular group, although it may be much more common in one assemblage of animals than in another.

Several attempts have been made to reduce the coloration of animals to some general law, and among these one of the most notable was published some years ago by Prof. Eimer, of Tübingen, who based his conclusions on a comprehensive study of vertebrates in general. As the result of his investigations, this observer declared that the following laws might be laid down in regard to colour-markings of animals in general. Firstly, the primitive type of coloration took the form of longitudinal stripes. Secondly, these stripes broke up into spots, retaining in many cases a more or less distinct longitudinal arrangement. Thirdly, the spots again coalesced, but this time into transverse stripes. And fourthly, all markings disappeared, so as to produce a uniform coloration of the whole coat. As a further development of this theory, it was added that the more specialised features were assumed in many cases more completely by the male than the female, while the primitive coloration often persists in the young. It was also stated that the primitive longitudinal stripes frequently persist on the middle of the back, and likewise on the crown and sides of the face, examples of the latter survival being shown by the head- and face-stripes of many spotted cats, and the dark and light streaks on the sides of the face of the badger.

Whether these laws hold good for other groups of vertebrates, it is not within the scope of the present article to inquire, and attention will accordingly be concentrated on mammals. If they be true, we should, *primâ facie*, expect to find a large number of longitudinally striped forms among the lower members of the class; while those of intermediate grades of evolution would be spotted, and the higher types either transversely striped or uniformly coloured. This, however, could only be the case, as a whole, if all mammals formed one regularly ascending series; whereas, as a matter of fact, they form a number of divergent branches, each containing specialised and generalised forms. The inquiry is thus rendered one of extreme complexity, although there ought, if the theory were true in its entirety, to be a considerable number of longitudinally striped species among the lowest groups of all. Unfortunately, palaeontology, from the nature of the case, can afford us no aid, which very materially adds to the difficulty. It may be added that in Prof. Eimer's scheme no distinction is drawn between light and dark markings—that is to say, between the total disappearance of pigment and an ultra-development of the same—and it is obvious that this may be of such prime importance that these two types of coloration may have nothing whatever to do with one another. Nevertheless, we may provisionally consider light and dark stripes and light and dark spots as respectively equivalent to one another.

With regard to uniformly coloured animals, there can be no question as to the truth of the theory, since the young of so many animals, such as lions, pumas, deer, pigs and tapirs show more or less distinct striped or spotted markings, which disappear more or less completely in the adult.

The occurrence of bands on the legs and sometimes on the shoulders of mules and dun-coloured horses, and likewise the presence of dark bars on the limbs of otherwise uniformly coloured species of cats, like the Egyptian cat and the bay cat, are further proofs of the same law. Moreover, the fact that in the young of pigs—and, to a certain extent, those of tapirs—the markings take the form of longitudinal stripes, whereas in the more specialised deer, whether young or old, they are in the shape of spots arranged in more or less well-defined lines, is, so far as it goes, a confirmation of the theory that spots are newer than stripes. And the presence of transverse stripes in the still more highly specialised antelopes tends to support the derivation of this type of marking from spots, especially if it be remembered that the harnessed antelopes are partly spotted. Still, it must be borne in mind that these instances apply only to light markings, which, as already stated, may have a totally different origin from dark ones.

There are, however, apparently insuperable difficulties as regards longitudinal and transverse striping in mammals. In the first place, instead of finding a number of the polyprotodont, or more primitive marsupials, showing longitudinal stripes, we have in this group only the three-striped and single-striped opossums thus marked, and in these the stripes are respectively reduced to the numbers indicated by their names. This, however, is not all, for the banded ant-eater takes its name from the narrow transverse white stripes with which the back is marked; while the thylacine, which cannot in any sense be regarded as a specialised type, is similarly marked with broader dark stripes, neither of these animals having any trace of a longitudinal stripe down the back. The water-opossum,

again, may be regarded as a transversely striped marsupial, although here the stripes are few in number and approximate in form to blotches. Although in the same order the dasyures are spotted with white, we have no black-spotted marsupial; and if such a type formed the transition between longitudinal and transverse stripes, surely some species showing such a type of coloration ought to have persisted.

Then, again, in the ungulates we have the zebra-antelopes, the gnus, and the zebras showing most strongly marked transverse dark stripes; but we have no dark-spotted forms in the whole order except the giraffes, while the only ones with dark longitudinal stripes are young pigs. And it would thus appear that, although all the animals above mentioned are highly specialised species, these tranverse stripes and dark blotches must have originated *de novo* quite independently in each of the groups in question. Indeed, when we remember that the coloration of zebras, antelopes, and giraffes is generally of a protective nature—the stripes of the former rendering the animals invisible on sandy ground in moonlight, and, to a great extent, also in sunlight, while the blotches of the latter harmonise exactly with the chequered shade thrown by the mimosa-trees among which they feed—it is incredible that both types should have been evolved, according to a rigid rule, from animals marked by dark longitudinal stripes.

Another instance of the same nature is afforded by the cats, in most of which the coloration appears to be mainly of a protective nature, plain-coloured species, like the puma and lion, having tawny coats harmonising with the sandy deserts which these animals often inhabit, while the vertical stripes of the tiger, although in some degree

resembling the perpendicular lights and shadows of a grass-jungle, are probably for the purpose of breaking up the outline of the body. The clouded markings of the marbled cat and clouded leopard assimilate with the boughs on which these species repose, and the spotted coat of the Indian desert-cat renders the creature almost invisible in stony deserts. To suppose that all such adaptations have been produced in the regular order required by the theory is as incredible as in the last case. There is, moreover, the circumstance that the young of the uniformly coloured lion and puma are spotted, thus giving an instance of the direct passage from a spotted to a plain-coloured form without the intervention of a transversely striped stage, precisely the same thing also occurring in the case of the deer. It should, however, be mentioned that lion cubs occasionally have their tails ringed like that of a tiger, instead of spotted in leopard-fashion; so that in this particular instance transverse stripes are intercalated between the spotted and the uniformly coloured stages.

If we look for the most primitive mammals with longitudinal dark stripes over the greater part of the upper surface, such types being wanting in the marsupials, we shall find them in the striped mongooses (*Galidictis*) of Madagascar, already mentioned. And as the civets and their allies are certainly the most generalised of existing carnivora (although the modern members of that order occupy a somewhat high position), this case tends, in a certain degree, to lend some support to the view that longitudinal dark stripes are an early type. The rarity of animals exhibiting this pattern over all their bodies, coupled with the frequent retention of a longitudinal dorsal stripe, are likewise in some degree confirmatory of the same view.

With regard to the conspicuous black and white stripes on the cheeks of the badger, and throughout the head and body in the skunks, South African weasel, and Cape polecat, it may perhaps be argued, with some show of reason, that we have an old type of coloration. In the badger this type of coloration is restricted to the face, where it is evidently retained to render the animal inconspicuous among the streaks of light and shadow as it peers out of its burrow. On the other hand, they may have been acquired for this special purpose. In the other forms, all of which are more or less evil-smelling creatures, a conspicuous general coloration is an advantage, as warning off other animals from attacking them in mistake for harmless kinds, and the boldly alternating stripes have accordingly been retained all over the body and rendered as conspicuous as possible.

I might dilate to almost any extent on the subject of spots and stripes; but sufficient has been adduced, in this and the preceding article, to indicate the interest attaching to the coloration of mammals, and to show how far we are from understanding what has brought about the present state of things. That uniformly coloured mammals form the climax of colour-evolution in the case of stripes and spots may be pretty safely admitted. It may further be considered probable that longitudinal dark stripes are an old type of coloration in at least some groups, although it does not follow that this will hold good for all, the marsupials being possibly an exception. Transverse stripes cannot, however, be made to accord with Prof. Eimer's theory, since not only do they exist in some of the most primitive of all mammals, but they reappear in certain specialised groups where there is no evidence of a previous spotted stage having been passed through. While,

therefore, it is far from improbable that there may be a certain substratum of truth in what we may call the "longitudinal-spotted-transverse-uniform" theory of coloration, I submit that in its present guise it cannot adequately explain the whole evolution of spots and stripes in mammals.

THE DOMESTICATION OF WILD ANIMALS

SOME time ago the Société d'Acclimatation de France published in its *Bulletin* an address delivered by Dr. E. Trouessart at the Conference held on January 12th, 1900, to discuss the question of the animals most suitable for acclimatisation and domestication. The author commences his address by stating that the present age is one of machinery and electricity; and that eventually the use of these will result in the total consumption of all the stored vegetable fuels, such as coal and petroleum, buried in the crust of the earth. When such a time comes, he argues, man will be compelled to rely once more exclusively on the labour of animals, which derive their nutriment and their power from the consumption of the living vegetable products of the earth. It is, therefore, urged that it is important to domesticate and acclimatise as many kinds of wild animals as possible before they are finally exterminated. And to support his argument for domesticating animals other than those now commonly held in subjection, Dr. Trouessart points out that while a certain area of country is only capable of nourishing a definite limited number of one kind of animal, such as oxen, it is perfectly able to sustain in addition some of another description, such as sheep, which are able to pasture on ground over which cattle have already gone and eaten all they could obtain. Pigs, again, have a totally different class of nutri-

ment; while the goat can obtain a living on ground where a sheep would starve. Moreover, the ass and the mule replace the horse in arid and mountainous countries, where they thrive on a much less luxuriant diet than is necessary to the well-being of the latter animal.

Then there are climates in which many of the domesticated animals of Europe will not flourish, dying either from the general effects of the climate itself, or succumbing to the attacks of insect-pests, as in the familiar instance of the African tsetse-fly.

As regards the supplementing of the existing domesticated animals of Europe—whether they be used for labour or for food—by newly domesticated wild species, I venture to think that, in the main, there is very little chance of success. In the first place, the species we now possess in this condition are amply sufficient to serve all needs, and are capable of indefinite multiplication. And in the second place, it has to be borne in mind that it would probably take scores of generations to make a wild animal equal in point of utility to the old-established domestic breeds—that is to say, it would take an immensely long period of time in order to make any wild animal as immune to the effects of in-and-in breeding as is the case with our domesticated species; while it is quite likely that the time would be still longer before the former would approach many of the latter in flesh-forming power or in the capacity for early maturity. And in this connection it is most important to bear in mind that the great majority of our domesticated animals are very different in physical characters from their wild ancestors; and that, in most instances, it is these highly modified breeds that are of the greatest economic importance to mankind. To produce an animal like the sheep, for instance, which differs from all its wild

kindred by possessing a coat of wool instead of hair, must have taken hundreds, if not thousands of years. And it is obvious that no newly domesticated species can by any possibility assail the established supremacy of the sheep. Again, it was attempted during the early decades of the last century to domesticate in England the South African eland, which it was thought might vie with the ox as a beef-producer, the experiment being carried out by a former Earl of Derby at Knowsley Park. But the experiment was a total failure, as these animals breed comparatively slowly, are long in coming to maturity, and bear no sort of comparison with shorthorns in capacity for rapidly putting on flesh.

Although, as noticed later on, there is a large field for the advocates of acclimatisation in introducing new species of animals into European parks and coverts, either for ornament or for sport, it seems to be tolerably evident that, in England, at any rate, the introduction and acclimatisation of new kinds of domesticated animals is not at all likely to be attended with successful results. Possibly, indeed, something of this kind may be accomplished in France, where the habits of the peasantry are different from those which obtain in England. But, so far as economical considerations are concerned, the chances of success in domestication are probably more hopeful in Africa than anywhere else. There the experimentalists have before them the grand opportunity of taming the African elephant, which, if its disposition is at all similar (and the individuals who carry loads of our young friends along the gravel paths of the London "Zoo" seem to indicate that it is) to that of its Indian cousin, ought to be invaluable as a means of transport. And they have a second scope for their ingenuity in producing a tsetse-proof

breed of zebra-hybrids, whose capacity for work and powers of endurance should be somewhat on a par with those of the horse and the mule.

Turning to the list of animals given by Dr. Trouessart as suitable for domestication or acclimatisation, we find it headed by the Patagonian cavy (*Dolichotis patagonica*) of the open plains of South America; a creature singularly like a hare in general appearance, although its affinities are with the guinea-pig. The mara, as this animal is called by the natives, has already been introduced into several English parks, notably those of the Duke of Bedford and Sir Edmund Loder, where it appears to flourish well, with a certain amount of protection. It does not burrow, but merely makes a "form" among long grass, after the manner of the hare. Its flesh is of excellent quality; and this, together with its interesting habits, is urged as the chief reason for its introduction. It is not, however, a rapid breeder, and to a considerable extent is diurnal in its habits and slow in its movements (except when thoroughly frightened); so that its chances of making its way in European countries, where hares are year by year diminishing in numbers, would appear to be but small. A second species (*D. salinicola*) inhabits the salt-plains of the Argentine, and it is accordingly urged that it would be suitable for turning down in the so-called *Chotts* of Algeria and Tunisia. But would the game be worth the candle? is the natural question.

With regard to the domestication of the African elephant, so much has been written elsewhere that I may be brief on the present occasion. It is interesting to notice, however, that the French missionaries of Fernan-Vaz, in the north of French Congoland, have succeeded in taming a young individual of this species, which appears to be the first of

its kind that has been domesticated in modern times in its native land. This animal was captured out of a herd of twenty, when apparently five or six years of age; and when the account was sent home had already become perfectly tame and docile. It was trained to draw a waggon for carrying agricultural produce, and also a brake for passengers. As Dr. Trouessart observes, this individual renders the domestication of the African elephant practically an accomplished fact.

There remains the question of breeding in captivity; but British experiences in Burma indicate that this is merely a matter of expense in the case of the Asiatic species. And it is worth considering whether domestication is not the only chance of saving the African elephant from ultimate extermination.

Perhaps even more has been written of late years with regard to the possibility of domesticating zebras than has been devoted to the case of the elephant. The general opinion seems to be that individuals caught wild and trained to harness are too "soft" to be of any great permanent value for draught purposes, and that either the stamina and staying powers of these animals will have to be improved by judicious breeding in captivity, or that mules between zebras and ponies will be found more efficacious for the needs of African transport. In either event it will be essential to domesticate a large stock of zebras, as otherwise in the course of a few years these handsome animals might become so scarce as to be practically unobtainable. Whether, however, "zebroids," as it is proposed to call the hybrids, will maintain the immunity against tsetse attack characteristic of pure-bred zebras, remains to be proved. There is also the question as to the fertility or otherwise of these hybrids, and the consideration that if they produced

offspring, these would almost certainly resemble their grandparents and not their parents. Another factor in the case must not be overlooked—namely, the absence of wild zebras from the great forest tracts, like Congoland, of Africa; and the consequent uncertainty whether these animals when domesticated would thrive in such districts. Possibly the hybrids might be found to do so, but it is quite likely that the pure-bred animals would require several generations of domesticity. Probably Grévy's zebra, on account of its large size and good shape, would be the species best adapted for domestication.

With regard to the acclimatisation of various species of foreign deer in European parks and forests, there is little doubt that many of the larger kinds, such as the American wapiti, would flourish and multiply. But such deer, especially after being kept in captivity, are apt to be spiteful at certain times of the year, on which ground their introduction is not altogether advisable.

The same remark will apply in a degree to the Altai wapiti, the Manchurian wapiti, and the large red-deer of the Caucasus and Persia. The pretty little Japanese deer (*Cervus sica*), and their somewhat larger cousin the Manchurian deer (*C. sica manchuricus*), both of which are fully spotted in summer, have, however, already been successfully introduced into parks in Ireland, England, and the Continent, where there is every prospect that they will continue to thrive. Moreover, the much larger and still more brilliantly coloured Peking deer (*C. hortulorum*) may be seen at liberty in numbers in the Duke of Bedford's park at Woburn; and from its comparatively large size, fine antlers, beautifully spotted summer coat, and generally handsome appearance, it is a species in every way suited for acclimatisation in Europe.

In spite, too, of the warm climate of its native home, the Indian spotted deer, or chital, takes kindly to a semi-wild life in Europe, where it may be seen in some of the parks of England, France, and Germany, the acclimatisation on the Continent dating from more than fifty years ago. At the time of its first introduction on the Continent nearly all the fawns perished owing to having been born in winter; but the females subsequently took to calving in spring, after which change of habit breeding has gone on successfully. Still it must be acknowledged that such an essentially exotic animal as the chital is much less likely to become permanently acclimatised in northern and central Europe than is a species like the Peking deer, whose home is in the steppes of Manchuria.

Hog-deer, which have the advantage that they do no damage to foliage, seeing that they are grazing animals, have been introduced into two French parks, and also run wild in the woods at Woburn. And the same is the case with the Indian and Chinese species of muntjac. During the cold winters of 1879-80 muntjacs were seen in a French park during the winter lying out on the snow and apparently enjoying themselves. For small parks these little deer are specially to be commended, as their diminutive size removes nearly all danger of a serious attack with their antlers.

The hornless Chinese water-deer is, however, absolutely innocuous in this respect; and it also has the further recommendation that it is much more prolific than any other member of the *Cervidae*, producing as many as half a dozen fawns at a birth. Of antelopes, several kinds have been more or less acclimatised in Europe. Most notable is the case of the nilgai in Italy, where in 1862 Signor Comba introduced a dozen head into his park at Mandria. Ten years later no less than 172 individuals were running at

liberty in the domain! A small herd is now in a thriving condition in the open park at Woburn Abbey. Reference has already been made to the eland, which may now be said to be thoroughly acclimatised in several French parks. There it apparently thrives without any winter shelter; but it would seem that this is an absolute necessity in England. All the above-named species of deer and antelopes have flesh of excellent quality; but for the most part, at any rate, their introduction into European parks must be regarded as a luxury, or for the sake of the sport they might afford, rather than as a commercial experiment.

The African sing-sing water-buck is likewise an antelope which appears to take kindly to wild life in Europe. It has bred for many successive years in Paris, and likewise flourishes in the park at Woburn. Other species of antelopes, as well as gazelles, might be mentioned, which there is good reason to believe would thrive in Europe; and it may be added that among the deer the Siberian roe, which is a much larger and finer animal than its European relative, is already established in the Bedfordshire woods.

Both the American and the European bison would almost certainly thrive in the parks of Western Europe, if the number of individuals introduced at first starting were sufficiently large; and herds of the former animal are now flourishing both in Bedfordshire and Northumberland. But the fierce disposition of these huge animals will almost certainly be a bar to their general introduction, in spite of the circumstance that "buffalo-robes" have a high commercial value.

Finally, as regards kangaroos and wallabies, numerous experiments have demonstrated that these animals, under certain conditions, are admirably adapted to thrive in most parts of Europe. By reason of their strange form and bizarre postures, they make attractive objects in a park,

especially where the ground is hilly or rocky; and their flesh is said to be highly palatable, while their skins are used both in the manufacture of gloves and as furs, although neither of these two latter considerations are likely to be of any importance in England. On an estate in Prussia a drove of the large kangaroo was kept in a condition of almost complete liberty in 1890; and at the present time various species of both kangaroos and wallabies are flourishing on the estates of the Duke of Bedford, Lord Rothschild, and Sir Edmund Loder. According, however, to information furnished to the writer by the owner of some tame wallabies, it is inadvisable to keep these animals in a small enclosure where there is any considerable extent of deep water occupying the line of country they are likely to take when frightened. Otherwise they are prone, when disturbed, to plunge headlong into the water, where not only will the adults stand a good chance of being drowned, but the helpless young in the pouches of the females must of necessity perish miserably.

As the result of all that has been written on the subject, it may be gathered that, with the exception of the domestication of the elephant and zebras in Africa (if this be found practicable), the acclimatisation of animals is unlikely to yield profitable results of any importance, at any rate in England; but that as a means of largely increasing the number of species of herbivorous animals kept in a wild or semi-domesticated state in parks and enclosures, it has an important future; and it may also prove to be the means of saving some of the most beautiful species from the fate of impending extermination which threatens not a few. In the case of persons of comparatively small means, Dr. Trouessart recommends that they confine their efforts to acclimatising a single species.

THE ORIGIN OF SOME DOMESTICATED ANIMALS

FEW subjects are hidden in greater obscurity than is th origin of many of our domesticated animals; and seein that man in all probability began to exercise his power dominion over the wild creatures by which he was su rounded at a very early date indeed, this is not mo than might be expected. When animals were first dome ticated, and which were the species that first came und the yoke of servitude, we shall never know. The availab evidence points, however, very clearly to the conclusion th Asia was the great original centre of the early domesticatic of Old World animals; although North-Eastern Afri seems also to have participated to a certain extent. So f as it goes this tends to confirm the conclusion that As has been the cradle of the human race, although it must l borne in mind that different races exhibit wide differenc in their capacity for domesticating animals; those of Afri being far inferior in this respect to many Asiatic tribes.

When any species of animal—provided that it will bre in this state—had once been domesticated, it is probab that the descendants of such domesticated stock have form the basis of all or most of the later breeds; for it obviously much easier to train such stock than to commen again *de novo* with a wild strain. Still, there are ma cases where subsequent crosses have taken place with

wild race, or races. From the point of view of their origin, domesticated animals may be divided into three classes. In the first class we have those which but seldom or never breed in captivity, and of which the domesticated race has constantly to be replenished by the capture and training of wild individuals. Apparently, the only two mammals coming under this category are the Indian elephant and the hunting-leopard. The latter can, however, only by courtesy be termed a domesticated animal, and may accordingly be dismissed from further notice. With regard to the elephant, the most curious feature is the readiness with which wild individuals submit themselves to servitude, and the aptitude they display for learning their allotted duties. Fortunately the elephant is an extremely long-lived animal, and therefore it has time to learn much during its period of captivity, while the necessity for fresh captures is proportionately diminished. Modern naturalists insist—and rightly so—on the inferiority of the intelligence of the elephant as compared with that of many domesticated creatures—the dog, for instance. But it is generally forgotten that, in consequence of its not usually breeding in captivity, there is no domesticated race which has acquired the experience and docility of years of servitude. And it is a subject for reflection to consider what might be the intellectual capacity of this animal had it been in continuous domestication for as long a period as the dog.

In the second class come those animals of which the ancestral wild stock is either still existing, or was so within the historic or prehistoric period. In this category come the horse, ass, ox, goat, and probably the cat and dog. The third class includes those domesticated animals of which the wild stock is not only extinct, but is likewise totally unknown.

Commencing with the camel, it is probably known to most of my readers that there are two kinds of this animal—namely, the two-humped Bactrian camel (*Camelus bactrianus*) of Central Asia, and the one-humped Arabian camel (*C. dromedarius*), now common to Asia and North Africa. It has been affirmed that wild Bactrian camels occur in the deserts of Turkestan, but it is almost certain that some at least of these are descendants of a domestic race which escaped from captivity about two hundred and fifty years ago. Others may, however, be truly wild. The only clue to the original habitat of the genus is afforded by the remains of fossil camels in North-Eastern India, Eastern Europe, and Algeria; and as the former occur in the older deposits, it seems probable that Central Asia is the cradle of the race. At what period the camel was first domesticated is lost in the mists of antiquity. From its absence in the Egyptian frescoes, it has been stated that this animal was unknown to the early inhabitants of the Delta of the Nile; but this is controverted by a papyrus of the fourteenth century B.C., in which reference is made to camels.

Considering the very large number of existing wild species of the genus *Ovis*, it is a very remarkable fact that we are unable to point to the ancestral stock of the sheep. As we know them in this country, domesticated sheep differ from their wild kindred by their woolly fleece, the wild species having hair more like that of a deer. But as some of the native domesticated sheep of Asia and Africa have a more or less hairy coat, the difficulty does not lie here. With the single exception of the arui, or Barbary sheep of Northern Africa, all wild sheep have short tails; whereas in the domesticated races this appendage, until docked, is very long. The reader may ask why

we do not regard the arui as the parent stock. To which it may be replied that the latter species has smoother horns, with a curvature quite unlike those of any of the domesticated races, which approximate to the horns of the Corsican muflon. It seems somewhat difficult to believe that a long tail can have been developed from a short tail—as precisely the opposite development is the only one with which we are acquainted; but, nevertheless, it has been suggested that the long tails of the domesticated breeds are a kind of degenerate development. If this be substantiated, there is no reason why the muflon—a European wild sheep, which in former times probably had a wider distribution—or some allied Asiatic species, should not have been the original progenitor of the domesticated breeds. A small breed of long-legged sheep, with somewhat goatlike horns, was in existence at the long-distant epoch when the inhabitants of the Swiss pile-villages flourished, and its descendants still survive in some of the more remote districts of the Swiss Alps, where the breed is known as the *bündnerschafe*. So far as it goes, this form suggests that the domesticated breeds are derived from an extinct species. Although domestic breeds were possessed by the ancient Egyptians, the sheep represented in the frescoes seems to be the wild arui.

With domesticated goats the case is very different; it being practically certain that most, if not all, of the breeds of Europe and Western Asia are derived from the Persian wild goat, or pasang, which ranges from Asia Minor through Persia to Afghanistan and Sind. This handsome species has long scimitar-like horns, with the front surface forming a sharp ridge, instead of being flattened and knobbed, as in the ibex. Many domesticated breeds have very similar horns; but in others, especially from Central Asia, the

horns are more or less corkscrew-like. As the wild markhor of the Himalaya has horns of a similar type, it has been suggested that many of the Asiatic breeds are derived from that species. Against that view is the circumstance that the direction of the spiral in the domesticated breeds is generally, although not invariably, just the reverse of that in the markhor. Although it is possible that some Asiatic breeds may trace their origin to the latter, it is more probable that they are derived from the pasang but have been crossed with the markhor. Most likely the goat was first domesticated in Western Asia, whence it was imported into Africa, where it has departed very widely from the original type. A superstition prevails in countries so wide apart from one another as Scotland and Kashmir that goats are deadly foes to snakes (the name "markhor" signifying *snake-eater*), and it would be very interesting to discover whether the legend has any foundation in fact.

The numerous breeds of domesticated cattle of Europe all trace their ancestry to the great extinct wild ox, or aurochs, which, as stated in another article, lived on in England at least as late as the Neolithic period, and survived to a much later date on the Continent. It has often been said that the white cattle of Chillingham Park are the direct descendants of the aurochs, but it is practically certain that they are derived from a domesticated breed. Many breeds, such as the so-called Celtic shorthorn, were established at an early period of human progress, and these have been incorrectly regarded as distinct species, although there is no doubt that they have the same ancestry. The geographical range of the aurochs was very extensive, and the original domestication may have taken place in Western Asia. The humped cattle of India seem to trace their origin to a distinct wild species now extinct, and the

ancestral form may perhaps be looked for among the extinct oxen whose remains are found in the gravels of the Narbada Valley. Some have, indeed, considered that humped cattle originated in Africa, where they are represented by the so-called Galla ox; but it is more probable that they are really of Oriental extraction and have been introduced into the Dark Continent.

During the immense period that they have been domesticated, the true oxen have displayed great adaptability to modification, as is exemplified by the difference between such breeds as Highland, Polled Angus, Galloway, Kerry, Devon, Longhorns, Shorthorns, and Jersey. Not so the buffalo of Asia, which, although long domesticated in India, and subsequently introduced into Egypt, and thence into Italy, has in nowise departed from the wild type, save as regards a somewhat smaller stature and a diminished length of horn. Certain other species of cattle, such as the gayal (*Bos frontalis*) of North-East India and the banting (*B. banting*) of the Malay countries, have been more or less domesticated by various Oriental races, although in the latter case the domesticated breed seems to be renovated from time to time with a cross of the wild stock. All these forms seem to be unadapted for variation, and consequently breed true. No attempt ever seems to have been made to domesticate the bison; while, true to their instincts, the natives of South Africa have never enthralled the buffalo of that country.

Till within the last few years the origin of the domesticated ass was a matter of some uncertainty, seeing that all the Asiatic wild asses differ considerably from the familiar animal. Recently, however, a wild ass has been brought from Somaliland which differs in no important character from the domesticated form, and is its undoubted

ancestor. Some of these Somali asses are, it is true, more striped on the legs than is commonly the case with the domesticated breed; but then some examples of the latter are nearly or quite as fully marked as the wild race, while some African specimens have nearly uniformly coloured limbs. Possibly the Somali wild ass may originally have ranged into Syria and Arabia; and, in any case, it is probable that it was first tamed there, and thence introduced into Europe. Indeed, the Greek name (*onos*) of the ass is stated to be derived from a Semitic root; and since this name occurs but once in the "Iliad," and not at all in either the "Odyssey" or in Hesiod, it has been inferred that the ass was a rare and little-known animal in Greece during the epic period.

Whether any truly wild horses have survived till modern times has been disputed. With the exception of the Mongolian Przewalski's horse, which does not seem specifically distinct from the domesticated *Equus caballus*, the only animals which can lay claim to that title are the so-called tarpan of the steppes of Central Asia, which formerly ranged as far westward as the Volga, but are now exterminated. Some authorities are of opinion that these tarpan are a truly wild race, while by others they are regarded as feral—that is to say, descended from a domesticated stock. It is certain that the droves of tarpan at times received an influx of feral animals; but whether they were feral or truly wild—and the evidence seems rather in favour of their wild origin—they undoubtedly resembled the ancestral type of the horse. This, of course, will be due in the one case to reversion, and in the other to direct inheritance. They were rather small, clumsily built animals, with remarkably ugly heads; their general colour being dun. During the Pleistocene period horses

of apparently similar type to the tarpan wandered over a great part of Europe and Western Asia, as is attested by their fossilised remains; and from other evidence it is probable that at the epoch in question the physical condition of much of Europe was similar to that of the Asiatic steppes at the present day. Such conditions would seem, indeed, to be essential for the existence of wild horses, which are animals specially adapted for a life on the open plains, where they find safety in flight. It is true that wild horses were found in parts of Europe at a much later epoch, when the country had become forest-clad; but it is quite possible that these were really feral races. When we come to the consideration of the place and time of the first domestication of the horse, the usual difference of opinion prevails among those most capable of forming a judgment. It was at one time considered that the horse was first domesticated in the East, but later authorities are more inclined to think that the wild horse was also subjugated by the stone-implement makers of Western Europe. This race is considered to have given rise to the ordinary European breeds; but thoroughbred horses are probably of Eastern origin. We naturally look to Arabia as the ancestral home of the Eastern breed; but this is a mistake, as the horse is known to be a comparatively late introduction into that country, the Arabs even as late as the time of Strabo having neither horses nor asses, and going to battle mounted on camels.

In the early days of Egypt—that is to say, during the period known as the "old kingdom"—the horse was unknown in the Nile Valley; the animal not making its appearance in the frescoes till about the year 1800 B.C. Probably the horse entered Egypt *viâ* Mesopotamia and Syria, where, as we learn from the Nineveh sculptures, it had long been

known. It has been well remarked that even these sculptures afford evidence that the horse was a comparatively new animal to the Assyrians—that is to say, these warriors were not such splendid riders as were the Parthians at a later date, and as are the Turkomans now. If any of my readers will visit the British Museum and inspect the Assyrian sculptures, he will scarcely fail to notice that, whereas those mounted warriors who are armed with the spear manage their own horses, such as carry a bow have their horses led by a comrade. Manifestly, the Assyrian warrior was incapable of managing his steed when both his hands were occupied with his weapon; and he was thus a far less accomplished horseman than the Parthian or the Turkoman.

Although the evidence is not decisive, the probability is that the horse was first introduced into Assyria from Persia. The ancient records of India indicate that horses were by no means common there, while such as there were excelled neither in strength, speed, nor beauty. The Indian climate is, indeed, unsuited to the animal; and there is no doubt that it was originally introduced from the north. But the original horse must have come from somewhere, and the probability is that the nomad Mongols in the east and the Turkomans in the west—still some of the most splendid horsemen the world has ever seen—were the first Asiatic tribes to subdue the noblest of man's servants. This being so, and Turkestan and Mongolia being the home of the tarpan and other wild horses, it follows not only that the latter are really wild, but that the thoroughbred of the East has the same ancestry as the underbred animal of the West, and consequently that "blood" is merely a matter of careful selection and breeding for countless centuries, and is not due to inherent superiority of origin.

From the plains of Turkestan the horse spread in one direction to the Punjab and the plains of Hindustan, and in the other through Persia to Mesopotamia and Assyria, and thence westwards to Egypt and southwards to Arabia. Among the Arabs it soon became indispensable to its master; and, as already said, this intimate union between man and quadruped renders it difficult to believe that Arabia is not the original home of the horse. Uncivilised races, though highly conservative in some matters, in others soon adapt themselves to new circumstances; and the case of the North American Indians affords an example of the rapidity with which a people among whom the horse was unknown can develop into a race of horsemen. Had we not historic evidence to the contrary, there is, indeed, no saying but that the original subjugation of the horse might have been attributed to the Indian of the prairies.

HOW ARCTIC ANIMALS TURN WHITE

ALTHOUGH I have not the details of any one particular case before me, so many instances are chronicled in which the hair of human beings, under the influence of strong mental emotion due to terror or grief, has become suddenly blanched within a single night or some such period of time, that the occasional occurrence of such a phenomenon must apparently be accepted as a fact. Such a change is, of course, due to the bleaching of the pigment with which the hair is coloured, although we need not stop to inquire by what particular means this bleaching is accomplished; all that concerns us on the present occasion being to know that the hair in man may turn white in this manner under abnormal circumstances. And there appears to be evidence that under equally abnormal conditions a similar change may take place suddenly in the hair of the lower animals. This is exemplified by the well-known experiment made considerably more than half a century ago by Sir John Richardson on an Arctic lemming—a small mouse-like rodent, which habitually turns white in winter, although dark-coloured in summer. In this instance the little animal was kept in a comparatively warm room till winter was well advanced, when it was suddenly exposed to a temperature of 30° below zero; a continued exposure to this and a still more intense degree of cold eventually resulted in its death, which took place within three

weeks of the commencement of the experiment. In consequence of the conditions under which it had been kept, this lemming was still brown in midwinter, when it ought to have been white. As the result of its first night's exposure, the fur on the cheeks and a patch on each shoulder became completely white, and by the end of the first week the whole coat had turned white. On examination it was found that only the tips of some of the hairs had become blanched, and that these white-tipped hairs were longer than the rest of the coat, apparently owing to a sudden growth on their part in the course of the experiment. By clipping these long white-tipped hairs the animal was restored to its original brown condition.

Nothing is said with regard to any change of coat on the part of this lemming previous to the experiment, but it is probable that none occurred. It seems, however, to be clearly demonstrated that the tips of the hairs lost their colour by bleaching, induced by sudden exposure to the intense cold, and that the hairs thus blanched increased considerably in length in a very short period.

In spite of the very obvious fact that these changes occurred under extremely abnormal circumstances, it has been argued that Arctic mammals which turn white in winter do so normally by a similar blanching of the hair of the summer coat, and that the greater length of the winter, as compared with the summer dress of such white animals, is due to a lengthening of the individual hairs of the former.* Moreover, it has been inferred that the colour-change is directly under the control of the animals themselves. Quite apart from many other considerations, one weak point in this argument is that the hairs in the subject of the experiment were white only at their tips.

* *See* E. B. Poulton, "The Colours of Animals," chap. vii. (1900).

It was doubtless assumed that, had the experiment been extended over a longer period, the white would have gradually extended downwards till the whole hair became blanched. But had this been the normal way in which the change from a black to a white coat is brought about, it is obvious that animals ought frequently to be captured in which the coat is in the same condition as that of the lemming. So far, however, as I am aware, no such condition has ever been described.

Moreover, it is perfectly well known that, apart from those which turn white in winter, a large number of animals have a winter coat differing markedly in colour, as well as in length, from the summer dress. The roebuck, for instance, is of a brilliant foxy red in summer, while in winter it is grey-fawn with a large patch of pure white on the buttocks. And it is quite clear that the change from red to grey, and the development of the white rump-patch, is due to the shedding of the short summer coat and its replacement by the longer winter dress. Obviously, therefore, it is natural to expect that a similar change of coat takes place in the case of mammals which turn white in winter.

That the change in spring from a white to a dark dress is due to a shedding of the fur seems to be admitted on all hands, for it would obviously be quite impossible for long hairs to become short, or for white ones to turn brown. And even in animals which do not alter their colour in any very marked degree according to season, the spring change of coat is sufficiently obvious. For the winter coat, owing to the long time it is carried and the inclemency of the season when it is in use, becomes much faded and worn by the time spring comes, and the contrast between it and the fresh and brilliant summer coat

is very striking indeed. On the other hand, the summer coat is only donned for a comparatively short season, and that at a time of year when it does not become much damaged by the effects of the weather. Consequently no marked change is noticeable as the long winter hairs grow up through it, and it has accordingly become a common article of belief that, whether there is a change of colour or not, the long winter coat is produced by a lengthening of the summer dress.

Apart from the evidence of animals like the roebuck and many other deer as to the existence of an autumn change of coat, as deduced from a difference in colour, the fact of such a shedding of the fur is demonstrated by the circumstance that in many species, as, for instance, the mountain hare, the individual hairs themselves, as seen under a microscope, differ appreciably in calibre at the two opposite seasons of the year. In that species, for example, the hairs of the winter coat are of a much finer character than are those forming the short dress of summer, which are comparatively coarse and thick. Moreover, in spite of the natural tendency to believe in blanching on account of the aforesaid abnormal instances of turning white in a single night, there is abundant evidence to show that even in human hair the change from dark to white as age advances is brought about by the replacement of dark hairs by white ones, and not by the bleaching of the former. In this case, however, the change, instead of being seasonal and sudden, is gradual and due to age. If the change was due to blanching, we should, of course, find some hairs which were partially white and partially brown (or black, as the case may be). And here it may be remarked that if such partially blanched hairs were met with, we should naturally expect to find that

it would be the basal half which was white, and the terminal half which retained its natural colouring—in other words, precisely the reverse of the condition obtaining in Sir John Richardson's lemming, thereby affording further presumptive evidence as to the abnormal condition of the change in that animal.

As a matter of fact, however, those of us who have reached an age when silver hairs have begun to make their appearance among the brown can easily satisfy themselves that such hairs are white throughout their entire length, and that a hair half white and half brown is quite unknown. From this we infer that the change from brown to white takes place in human beings by the gradual shedding of the dark hairs and their replacement by new ones from which pigment is entirely absent. So that normally there is no such thing as bleaching of individual hairs. The change is, indeed, precisely similar to the one which takes place at the approach of winter in mammals that habitually turn white at that season, with the exception that, as a general rule, it is extremely slow and gradual, instead of being comparatively rapid, and also that the white hairs differ from their dark predecessors solely by the absence of colouring-matter. Unfortunately, there is no subsequent replacement of the white hairs by dark ones!

The fact that the change from brown to white in the mountain hare (*Lepus timidus*) is really due to a change of coat and not to bleaching was known at a very early period to the English naturalist Pennant; and the existence of this change was likewise recognised by Macgillivray. It was not, however, till Dr. J. A. Allen, in a paper on the colour-change in the North American variable hare published in the *Bulletin* of the American Museum of Natural History for 1894, demonstrated by actual experiment the

truth of Pennant's statement, that the fact of the complete autumnal change of the coat in animals that turn white in winter was generally recognised by naturalists. So far as the spring change from the white to the brown dress is concerned, his conclusions are fully confirmed by Capt. G. E. H. Barrett-Hamilton, who communicated some interesting notes on the change in the European mountain or variable hare to the *Proceedings* of the Zoological Society of London for 1899. The fact that the vernal colour-change is due to the shedding of the coat seems, however, as already mentioned, to have been much more generally admitted than was the case with regard to the autumnal transformation.

Dr. Allen arrives at the conclusion that both the autumn and the spring change take place periodically and quite independently of the will of the animal, and also that they are but little affected by phases of the weather, although they may be somewhat retarded or accelerated by the prevailing atmospheric temperature.

So far as the fact of the seasonal change being normally beyond the control of the animal in which it occurs, Capt. Barrett-Hamilton is in full accord with the American writer; but he goes somewhat further, and believes that it is quite uninfluenced by temperature, or at least by such variations of the same as may be met with in different parts of the area of the British Islands; and, as we all know, these are considerable!

As in the case of many other animals—deer, for instance—the change from the winter to the summer coat takes place very late in the season in the mountain hare in Scotland, specimens undergoing the change being often seen early in May. But the date of the spring change is no earlier in the south of Ireland, where the climate

is much milder, although the amount of whiteness assumed in that district is very much less than in the north. This seems to demonstrate the contention that temperature has little or no influence on the change, so far as season is concerned.

That the animal has no control over the change from brown to white in autumn seems to be proved by instances referred to by Capt. Barrett-Hamilton, "in which variable hares transported from Scotland and from Irish mountains to southern and low-lying regions continued for some seasons to appear in the northern garb of snowy whiteness. This persistence of the habit of turning white, even in unsuitable conditions, together with the lateness of the moult, resulted frequently in the curious spectacle of a mountain hare running about in all its conspicuous Arctic livery under the bright rays of an April or May sun. After a few years such imported hares, or more probably their offspring, ceased to turn completely white, and the breed assumed the appearance of the ordinary hares of the southern locality to which they had been transported."

It would, of course, be extremely interesting to ascertain whether such transported individuals ever do give up the practice of turning white in winter, or whether it is only their offspring that do so ; but, in any case, it is clearly demonstrated that the habit is very deep-seated and difficult to overcome.

Very curious is the circumstance that the mode in which the coat is changed in the variable hare at the two seasons of the year differs *in toto* as regards the parts of the animal first affected. On this subject, with one verbal change in the first sentence, I quote from Dr. Allen, who writes as follows :—

"In the fall the change begins with the feet and ears,

the sides of the nose and the front of the head, which often become radically changed before the body is much affected; while as regards the body, the change begins first at the base of the tail and extreme posterior part of the back, and at the ventral border of the sides of the body, working thence upward towards the middle line of the back, and from behind anteriorly, the crown of the head and a narrow median line over the shoulders and front part of the back being the parts last changed. In the spring the order of change is exactly the reverse, the moult beginning on the head and along the median line of the anterior half of the dorsal region, extending laterally and gradually to the ventral border of the sides of the body and posteriorly to the rump, and then later to the ears and down the limbs to the feet, which are the parts last affected, and which often remain but little changed till the head and body have pretty completely assumed the summer dress."

It is very hard indeed to conjecture any satisfactory reason for this remarkable difference.

The American variable hare ranges, at ordinary levels, about as far south as Massachusetts—that is to say, nearly to the latitude of Madrid, and throughout the whole of this extensive tract it turns white in winter. On the other hand, owing to the much milder climate of Western Europe, no colour-change takes place in the mountain hares of Ireland, while it is reported that in those introduced into Ayrshire and the neighbouring counties of south-western Scotland the change is much less complete and regular than in those inhabiting the northern parts of the country.

An impression appears to be prevalent that in the more northern portion of their range both the mountain hare and

the ermine (or stoat) are white at all seasons, but this does not seem to be authenticated.

Observations are wanting as to whether the changes of coat and colour in the mountain hare bear any relation to the appearance and disappearance of snow, or whether they occur regularly at the same season of the year. In the case of the ermine in the Adirondack region of New York, Dr. C. H. Merriam tells us that in this animal the white livery is assumed only after the first fall of snow, while the resumption of the brown coat does not take place till the snow begins to melt. Unfortunately, he says nothing in regard to change of coat. The late Dr. Coues stated, however, that in the case of the ermine the bi-annual change of coat takes place at the same season, but that it depends upon the condition of the temperature at the time whether the new coat differs in colour from its predecessor. In other words, the change from brown to white might be due either to shedding the coat or to bleaching of the hair subsequent to such shedding. The case of the mountain hare is, however, strongly suggestive that the colour-change is in all instances coincident with the shedding of the coat.

It is, of course, quite evident that the assumption of a white winter livery by mountain hares and ermines living in regions where the snow lies on the ground for a considerable portion of the year is for the purpose of rendering such animals as inconspicuous as possible when in their native haunts. And, so far as we know, such a change is universal among the species named when dwelling in high northern latitudes.

There is, however, another animal inhabiting the North Polar regions of both hemispheres in which the change to a pure white winter dress is limited to certain indi-

From photographs by the Scholastic Photographic Agency.]

ARCTIC FOXES.

The lower figure shows the white phase in winter coat; the upper figure is probably the same phase in summer dress; the central figure may be the blue phase.

[*To face p.* 66

viduals. The species in question is the Arctic fox, of which the beautiful fur, in both the white and the blue phase, is, as mentioned in a later article, now much affected by ladies. That both the white and the blue individuals of this species are in the winter dress will be evident to every one who examines such furs carefully, the length and thickness of the hair being quite decisive on this point.

With the single exception of Iceland, where they are always blue, it appears that the white and the blue phase are met with throughout the habitat of the species. In other words, the animal is "dimorphic," if it be permissible to apply this term to a case where the difference between the two phases of a species is restricted to coloration.

What makes the matter so puzzling is this: if blue foxes are able to thrive during winter in a snow-clad country, what necessity is there for their fellows—and, indeed, for any species—to turn white at that season of the year? An explanation of the case of the blue foxes has been attempted in the article already referred to.

Since the present article was written important additional information with regard to the manner in which hair bleaches has been afforded by a communication from Mr. E. Metchnikoff, published in the *Proceedings* of the Royal Society for 1902. It is there stated that the all-devouring cells known as phagocytes are the cause of the mischief. These cells, which frequently have amoeba-like processes, are developed in the central or medullary part of the hair, whence they make their way into the outer or cortical layer, where they absorb, and thus destroy, the pigment-granules. Numbers of these phagocytes may be seen in hair which is commencing to turn white.

"The part played by phagocytes," writes the author, "in the whitening of the hair explains many phenomena observed long ago, but not as yet sufficiently understood." Thus the phenomenon of hair turning white in a single night, or in a few days, may be explained by the increased activity of the phagocytes, which remove the pigment within an abnormally short period.

A LAND OF SKELETONS

NEXT to Australia, which, as regards its fauna, stands quite apart from the whole of the rest of the world, South America possesses a greater number of peculiar types of animals than any other region at the present day. A traveller, for instance, starting from Europe may wander eastwards across the northern part of Asia as far as Japan without ceasing to meet with types of mammals and birds perfectly familiar to him, while the same is, to a great extent, the case if his footsteps are directed to India or Africa. It is true, indeed, that in both the latter countries he will come across creatures like elephants and rhinoceroses, which are now unknown in Europe, while in Africa he will be confronted by hippopotamuses, giraffes, okapis, and ostriches. All these animals, however, once existed in Europe during the later portions of geological history, and may accordingly be counted as pertaining to the European fauna. Still more striking is this similarity of the fauna with that of Europe if the traveller's route happen to lie across the northern half of the New World, where he may meet with many mammals, such as the bison, Rocky Mountain sheep, grizzly bear, wapiti, elk, reindeer, wolf, and fox, more or less closely allied to Old World forms. On the other hand, when South America is reached, it will be found that not only are all the mammals and birds specifically different from those of Europe, but likewise that many of them belong to genera

or groups absolutely unknown beyond the confines of that country, while Old World types are relatively scarce. For instance, the whole of the typical representatives of that group of mammals technically termed edentates, such as armadillos, ant-eaters, and sloths, are exclusively confined to South and Central America; while the monkeys of that continent are quite different from those of the Old World, and, like the pretty little marmosets, are peculiar to the former area. The camel-like animals known as guanacos and vicunas, together with their domestic representatives, the llamas, are likewise at the present day exclusively characteristic of South America, although there is reason to believe that they were originally introduced from the north. Then, again, opossums (which, by the way, must not be confounded with the creatures commonly so called in Australia) are among the most characteristic of South American mammals, although some range as far north as the United States. The rodents, or gnawing mammals, are likewise remarkable, not only for their numerical abundance, but likewise for the large size of several of their members which belong to genera peculiar to the continent. Among these the capivara or carpincho (*Hydrochoerus*), commonly known as the river-hog, is the largest living member of the order, its skull measuring about a foot in length. Another characteristic aquatic type is the coypu (*Myocastor*), generally termed by Europeans nutria (properly the Spanish name for an otter), and easily recognised by its red incisor teeth. Of the terrestrial species the most familiar is the viscacha, which inhabits warrens, like the prairie marmot of North America, with which, however, it has no affinity.

But not only is South America remarkable for the number of peculiar types of mammals it contains, but it is likewise

noteworthy for the absence of a number of Old World and North American forms, this paucity being specially noticeable among the ungulates or hoofed mammals, which are represented solely by the aforesaid guanaco and its allies, by a group of deer differing considerably from all Old World species, although represented in North America, and by several species of tapirs—the latter animals being at the present day known elsewhere only by a solitary kind from the Malay region, although they were formerly abundant over a large portion of the Old World. Consequently, such well-known and important groups of ungulates as oxen, goats, sheep, antelopes, horses, rhinoceroses, hippopotamuses, and elephants are totally unknown in a wild state at the present day in South America, although two of them—viz., horses and elephants—formerly existed there.

Equally characteristic are the birds of South America. Although it is only possible here to make allusion to a few among these, I may especially mention the entire group of humming-birds, together with a peculiar family of perching birds commonly known as wood-hewers, and technically as the *Dendrocolaptidae*, of which the well-known oven-bird (so called on account of its dome-shaped mud nest) is a familiar example. The large gallinaceous birds termed curassows and guans are also very characteristic, while still more distinctive of the country are the tinamus, which, although structurally allied to the ostriches, are so like partridges in form and habits that by English residents in the country they are universally so termed. Another characteristic South American bird commonly misnamed by Europeans is the rhea, this bird, which is almost always designated an ostrich, differing from its African relative by having three toes instead of two. Yet another remarkable avian type is to be found in the large and somewhat

goose-like chaja (pronounced chahá), or horned screamer, which takes its English name from the spur on its wing and its loud cry, the latter being sometimes heard when the bird is so high in the air as to be almost or quite invisible. The long-legged seriema, which stalks over the plains in the manner of the African secretary-bird, is like-wise a very characteristic type. Among characteristic South American reptiles may be mentioned iguanas (a name often applied incorrectly to lizards from other parts of the world) and caimans; the latter being a group of alligators distinguished by having an armour of bony plates on the under as well as on the upper surface of the body. The huge horned frogs (*Ceratophrys*) are like-wise distinctive of the country among the batrachians.

Such are a few of the leading features of the existing fauna of South America, which are sufficient to show how totally different is the animal life of this country from that of all the rest of the world. If, however, we go back to the later geological periods of the earth's history, we shall find that this peculiarity and distinctness of the South American fauna was even more intensified than at the present day, this being largely due to the circumstance that at one time the isthmus of Darien seems not to have existed, so that the northern and southern portions of the New World were disconnected. Since the time when a connection was formed between the two continents, their faunas have, however, naturally tended to blend together, and hence at the present day, and during the Pleistocene period, the animals of South America are less sharply differentiated from those of the northern half of the continent than would have been the case had the isthmus of Darien not been formed. It is further interesting to note that during the Tertiary period there appears to have

been some kind of connection between the faunas of South America and Australia.

The country that has afforded the most information with regard to the extinct fauna of South America is the Argentine Republic, which includes not only Buenos Aires and the adjacent provinces forming Argentine proper, but likewise the whole of Patagonia. Confining our attention, in the first place, to the province of Buenos Aires and some of the neighbouring districts, we may note that the greater part of this vast tract of country is one boundless level plain formed by an alluvial deposit of rich black mud brought down from the higher lands of the interior by the tributaries of the Rio de la Plata, and constituting the most extensive pasture-land in the world. Near Buenos Aires and the valley of the Rio de la Plata this alluvial deposit, which in places alternates with sandy beds, is of immense thickness;* but farther to the south it thins out rapidly. In some places in the neighbourhood of La Colina, about a hundred miles from Bahia Blanca, for instance, the black soil is not more than a couple of feet in thickness, and is underlain by a hard white calcareous deposit, locally known as "tosca," and much resembling some of the deposits formed by hot springs.† That the black alluvial deposit, which, from forming the whole of the Pampas, or plain country, is known to geologists as the Pampean formation, is of fresh-water origin is perfectly clear, and it is probable that it was largely formed in marshes and swamps, one of its most striking features being the total absence of pebbles or stones. Indeed, throughout the country, except in the neighbourhood of the mountains,

* Near Buenos Aires it has been bored into for depths of fifty and ninety feet.

† At Buenos Aires the alluvial deposit itself is called "tosca."

there is not a vestige of rock or stone to be seen, unless it be in the few places where the aforesaid "tosca" has been brought to the surface. In spite of its fresh-water origin, there is, however, evidence that portions of the Pampean formation have been submerged beneath the sea. For instance, in the neighbourhood of the city of La Plata there occurs a bed of marine shells overlying the alluvial mud, all the species of molluscs being now found living in the Bay of Monte Video. I have also observed a similar bed at Santa Lucia, in the Banda Oriental, at an elevation of about one hundred feet above the sea, which was overlain by a considerable thickness of sands; and the same deposit occurs far inland, at the town of Parana. From these data it may be inferred that after the temporary subsidence of the Pampas, during which the marine beds were deposited, there has been a considerable elevation (which is probably still going on) of the whole country; and that these movements have taken place at a very recent epoch indeed.

At the present day the Argentine Pampas, with the exception of a few willows along the river courses, is practically destitute of trees (save where they have of late years been planted around the various settlements), and forms a boundless sea of grass, relieved here and there by tussocks of the tall Pampas-grass, or giant thistles, and adorned in spring with scarlet verbena and other bright-hued flowers. Till the introduction of the countless herds of horses, cattle, and sheep, which now roam over its extent, this vast tract of country was tenanted by the guanaco, the Pampas-deer, the viscacha, and the rhea, which, with the exception of certain carnivores, were almost the only animals of any size to be found throughout its length and breadth.

The rich black alluvial mud of the Pampas, which, as we have seen, is entirely of fresh-water origin, is, however, the tomb of thousands, if not millions, of the skeletons and bones of a host of extinct animals, which tell us that the country was once inhabited by a fauna stranger than that found in any other part of the world at any epoch of its history. While many of these extinct creatures were allied to the existing South American mammals, although of vastly greater bodily size, others, of equally gigantic dimensions, were quite unlike all known animals, either living or extinct. As some of these extinct mammals are noticed in the next article, I make but brief mention of them here. It may be observed, however, that, while the gigantic glyptodons were the representatives of the diminutive armadillos of to-day (although some of the latter flourished side by side with their huge cousins), the megalothere, which rivalled an elephant in bulk, together with its allies the mylodons, were akin both to the sloths and the ant-eaters of Brazil, and as they were certainly terrestrial in habits, they are called ground-sloths. From the structure of these animals, which were evidently adapted to sit up on their massive haunches and tear down the branches of trees with their powerful front claws, it may be inferred that the physical features of this part of Argentina were once very different from what they are at present, and that in place of continuous tracts of unbroken grassy plain there were probably large areas of forest-land, as in Brazil at the present day. In these forest tracts probably wandered the two species of mastodons which were the contemporaries of the ground-sloths; but the existence at the same time of several species of horses (some closely akin to living species, while others were markedly distinct) seems to point to

the presence of grassy plains alternating with the forest. The same is probably indicated by the numerous species allied to the guanaco, which flourished at the same time, and some of which attained the dimensions of a camel, while the various kinds of deer may also have inhabited the same regions. The gigantic hoofed mammal known as the *Toxodon*, which had ever-growing teeth like those of a rodent, was, however, probably an inhabitant of swamps and marshes, while the still more extraordinary *Macrauchenia*, with its slender, camel-like neck and long, three-toed limbs, probably stalked over the plains, cropping here and there the foliage from some tree or copse. Rodents nearly related to existing South American types were likewise common, and there were also certain large carnivores, such as a species of sabre-toothed tiger and a huge bear-like creature. With the exception of these carnivores, together with the guanacos, horses, deer, and mastodons, which are unknown in the older formations, and are therefore probably late immigrants from the north, all the animals of the Pampean formation are peculiar to South America. A further distinctive feature of this fauna is the large bodily size attained by so many of its representatives, this being especially the case with the glyptodons, mylodons, megalotheres, guanacos, mastodons, macrauchenias, and toxodons, all of which would come under the designation of giant animals. In this respect the Pampean fauna corresponds with that of the Pleistocene period of Europe, with which it also agrees approximately in age, seeing that there is evidence of the contemporaneous existence of man with several of the extinct mammals.

In certain parts of the Pampean formation the remains of these animals occur in extraordinary profusion, and generally in a perfect state of preservation. At times they

are found sticking out from the perpendicular cliffs, or *barancas*, bordering the river-valleys, while many are met with in sinking wells or making other excavations. In well-digging, of course, only a portion of a skeleton is obtained in the case of a large animal, which is the cause of the imperfect condition of many specimens in European museums, and it is only when excavations like those during the construction of the docks at La Plata or Buenos Aires are made, that entire skeletons are obtained, unless, indeed, special works are undertaken for the purpose of obtaining fossils. It does not, however, appear that the remains are at all evenly distributed through the mud of the Pampas, some localities being much richer than others, among these Lujan (pronounced Luhán), near Buenos Aires, being especially notable.

Although the Museum of the Royal College of Surgeons contains an entire skeleton of a megalothere, together with the shell of a glyptodon, while the British Museum is the fortunate possessor of a complete specimen of a mylodon, the museums of Europe afford a very poor idea of the number and beautiful preservation of these marvellous fossils. To gain any idea of the true state of the case it is necessary to visit the museums of Buenos Aires and La Plata, and more especially the latter. There the visitor will be absolutely lost in astonishment at the long array of perfect mounted skeletons of numbers of these creatures, while the unmounted skeletons and isolated bones displayed in the wall-cases will convince him that I am not exaggerating when I call Argentina a land of skeletons.

That the animals I have spoken of should have died off one after another through the long ages during which the mud of the Pampas was accumulating, is in accordance with what we should expect to occur, while the perfection

of their preservation is sufficiently accounted for by the nature of the deposit itself. The marvel, however, is in regard to the total disappearance of the whole of the larger forms and the reduction of the fauna of the Pampas to its present condition, together with the concomitant loss of the forests. It is not that the country is unsuited at the present day to the existence of the larger types of animal life, as witness the countless herds of horses and cattle with which its plains are now covered, together with the luxuriance and rapidity with which many kinds of trees flourish when introduced. Neither, I think, can it be due to a glacial epoch (although there appears to be evidence of the prevalence of a cold period in Patagonia), since any glaciation of the Pampas would have assuredly removed the greater part of the alluvial formation, besides having left indisputable evidence of its presence. Man can scarcely be credited with the extinction of either the fauna or the flora. It has been suggested that the number of guanaco with which the country was overrun previous to European settlement may have caused the destruction of the forests; but we must remember that similar animals existed in greater variety during the Pampean period, while even if the disappearance of trees were due to their agency, this would have had no effect on plain-loving forms like horses. That the disappearance of the latter animals may have been due to the number of pumas is another suggestion, but it will be obvious that this could have had nothing to do with the destruction of gigantic creatures like the glyptodons and ground-sloths. The problem is further complicated by the circumstance that the remains of many of these creatures occur in caverns in the interior of Brazil, where the climate is still, and probably always has been, tropical. It would seem, therefore, that we must be content to regard

the depletion of the fauna and flora of Argentina as one of the unsolved problems of science.

In regard to other formations, it must suffice to say that at Parana, and also on the coast at Monte Hermoso, near Bahia Blanca, there occur certain Tertiary deposits which are evidently somewhat older than the Pampean beds, although containing a closely allied fauna. The most interesting feature connected with this formation (which may probably be correlated with the upper Pliocene of Europe) is that the mammals are for the most part of smaller size than their relatives of the Pampean, this being especially shown by the glyptodons, and by those ground-sloths known as scelidotheres, which are near allies of the mylodons. When we reach the still older beds of Santa Cruz, in Patagonia, which are probably of Miocene age, we find not only this diminution in the size of the mammals still more marked, but we likewise notice the disappearance of all the northern forms, such as deer, horses, guanacos, and mastodons, thus showing that we have reached the period when South America was disconnected from the northern half of the continent, and possessed an absolutely peculiar fauna. Instead of glyptodons with a shell of eight or ten feet in length, we meet with species in which the carapace did not measure more than a yard; while in place of mylodons bigger than a rhinoceros we are confronted with a species not so large as a Highland sheep. The camel-like *Macrauchenia* was likewise represented by several much smaller allies, while the various species of *Nesodon*, which represented the gigantic *Toxodon* of the Pampean, were either small or moderate-sized animals. Somewhat curiously, there were, however, several kinds of gigantic flightless birds, which are quite unknown in the higher beds, and appear to have been allied to the existing seriema of Brazil.

would, however, show that while the middle toe is not markedly larger than either of the others, the bones of the wrist are arranged on the linear plan, while in the ankle the upper surface of the huckle-bone is nearly flat, or intermediate between that of the elephants and the odd-toed ungulates. Omitting mention of certain other minor peculiarities in the structure of the limbs, if we now turn our attention to the teeth, we shall see that these also present features unknown in any living ungulates. We find, for instance, in the first place, that the upper jaw is furnished with two pairs of permanently growing chisel-like teeth, comparable to the single pair of incisors in the rodents or gnawing mammals; these being opposed by three pairs of nearly similar, although horizontally placed, lower teeth. Such permanently growing incisor-teeth are paralleled among existing ungulates in the hyrax, but the toxodon stands alone in the order from the circumstance that the cheek-teeth likewise grow throughout life, instead of forming roots. Here, then, we have another point of resemblance in the toxodon to the rodent order. When we examine the form of the grinding surface of these cheek-teeth, there does not appear any marked resemblance to those of any existing ungulates. The link is, however, furnished by certain allied forms from the older Tertiary beds of Patagonia, known by the name of *Nesodon*, of which the first fragmentary remains were brought to Europe by Darwin, in the *Beagle*; the toxodon being confined to the Pampean deposits and the underlying beds of Monte Hermoso. Now, in the nesodons, the structure of the cheek-teeth clearly approximates to that characterising the odd-toed ungulates, although belonging to what naturalists term a more specialised type. It is further noteworthy that in these nesodons, although the cheek-

teeth grow for a considerable portion of life, yet they eventually form roots in the ordinary manner; the same being true of the incisors, with the exception of a single pair, which grow permanently. We see, therefore, that the permanently growing teeth of the toxodon are a specialised feature, and the older genus shows that these animals are clearly allied to the odd-toed ungulates, although sharply distinguished by the structure of the feet. Indeed, since their feet are of a more generalised type than those of the latter (as is especially shown by the almost flat huckle-bone), while their teeth are more specialised, it is evident that neither group can be ancestral to the other. Hence the toxodon and its allies may be regarded as forming a separate group of equal value with the other subdivisions of the great ungulate order. When these remarkable creatures branched off from the primitive ancestral types of the latter, and how they first obtained an entrance into South America, where they gradually increased in size and specialisation till the period of the Pampean, when they finally disappeared, are still unsolved problems.

The interest of the toxodons does not, however, by any means end here. Although, as we have seen, the toxodon itself shows certain resemblances to rodents in the structure of its teeth, it will be evident that such resemblances indicate no genetic affinity between the two groups, since rodents are neither the ancestors nor the descendants of the toxodons. In a much smaller animal, known as the typotherium, these rodent resemblances are still more pronounced, as is especially shown by the incisor-teeth, which are essentially those of a rodent. Moreover, in the hind-feet the toes have lost the hoofs characterising the more typical ungulates, and were probably protected by small nails. A still further step is exhibited by a much

smaller Argentine mammal, of the approximate size of a hare, named *Pachyrucus*. If it were not for the intermediate links, this creature would almost certainly be put down as a rodent, with which group it agrees in the structure of its teeth and toes, as well as in many other parts of the skeleton. Nevertheless, it is clearly a near ally of the typotherium, and therefore a member of the toxodon group. Here, then, we have one of the most remarkable instances of the phenomenon of parallelism in development. We have, in fact, displayed before us the origin of what we may call a rodent-ungulate: that is to say, an animal which, while certainly an ungulate by descent, has acquired such a marked resemblance to a rodent that, if we had not the intermediate links, it might be regarded as a member of the same order. This instance gives us some insight into the intricacies of evolution, and serves to show the amount of value attaching to many phylogenies of the animal kingdom.

In addition to the slightly grooved huckle-bone, the toxodon group is characterised by at least one of the upper incisor-teeth growing throughout life, and by the cheek-teeth being either rootless or not forming roots till very late. There is, however a second group of allied extinct ungulates peculiar to the Argentine in which all the molars are rooted at the usual period, while the huckle-bone is as flat as in the elephants, although of somewhat different form. This group is represented solely by two genera, both of which are confined to the Patagonian deposits, where they are represented by animals rivalling rhinoceroses in size, and furnished with molar-teeth somewhat resembling those of the latter. One of these creatures, on which the name of *Homalodontotherium* has been conferred, presents the rare peculiarity of having the teeth arranged in a

regular even series without gap or interval, and with their crowns of equal height. Very different in dental character are the members of the allied genus *Astrapotherium*, in which each jaw was furnished with a huge pair of tusks, those of the lower jaw curving outwards and upwards after the manner of those of a wild boar, while both were kept sharp and keen by their points wearing against one another. In the presence of these enormous upper tusks, the astrapotheres resembled the extinct uintatheres of North America, although they differed in the possession of tusks in the lower jaw, while it is probable that those of the upper jaw were incisors instead of canines. One of the most curious features connected with these animals is the close resemblance of their upper cheek-teeth to those of rhinoceroses, the similarity being so marked that if we were acquainted with the South American animal only by these teeth, it would probably be classed with the rhinoceroses. From the structure of the bones of the ankle it is, however, quite certain that these two groups of ungulates have no direct connection with one another, and that their common ancestor had teeth of a much simpler type of structure. It follows, therefore, that the form of cheek-teeth characterising both the astrapotheres and the rhinoceroses has been evolved independentiy in the two groups, and that we have consequently here another case of parallelism. Although this type of tooth (which, it must be remembered, is one of considerable complexity) is admirably adapted for crushing vegetable substances, it is by no means the only one which could have been evolved from what we may probably regard as the primitive type, and it is therefore difficult to see how it can have been produced by evolution unaccompanied by design.

Strange as are the foregoing creatures, they are exceeded in this respect by the long-necked and long-limbed animal named *Macrauchenia* (on account of the elongation of the vertebrae of the neck), specimens of which were first brought back by Darwin from the superficial deposits of Patagonia. In general form the macrauchenia somewhat recalls a camel; and it is a curious circumstance that, in common with that animal and its allies, it differs from all other ungulates, with the exception of certain kindred Argentine forms, in that the arteries of the neck pierce the sides of the vertebrae to take a course within the spinal canal, instead of passing merely through a loop of bone on the exterior. This remarkable resemblance is not, however, indicative of any affinity between the two animals, since, if we look at the feet of the macrauchenia, we shall find that they are of the odd-toed type, and each furnished with three digits. Moreover, the huckle-bone has the pulley-like upper surface characterising the odd-toed ungulates; and as the teeth approximate to those of the latter, we might be inclined to place the creature in that group. The wrist- and ankle-joints are, however, formed on the linear plan, and exhibit certain other departures from the odd-toed type, and it is therefore evident that the macrauchenia and its allies constitute a third group of extinct ungulates peculiar to South America. Although it is by foot-structure that the macrauchenia is separated from all other members of the order, its most remarkable peculiarity is to be found in the structure of its skull. In an ordinary mammal the aperture of the nose is situated quite at the anterior extremity of the skull. In the macrauchenia, on the other hand, this aperture forms an egg-shaped vacuity in the forehead, almost between the eyes. Some approximation to this remarkable arrangement is presented by

the living tapirs, but it is more nearly paralleled by the elephants, and still more closely by the aquatic dugong, while among whales the backwardation (if I may coin a word) of the nostrils is carried to a still greater degree. That a land mammal with its nostrils situated in this unusual position could not have managed to exist without a trunk seems evident, and we may therefore conclude that the macrauchenia was so furnished; while, from its long slender neck and limbs, it may further be inferred that it was an inhabitant of open plains or thin forest, and was not a frequenter of marshes and swamps. It may be added that in its uninterrupted and even series of teeth the macrauchenia differs from all existing mammals save man, and agrees with its distant cousin, the homalodonto-there.

From its large size, the peculiar position of its nostrils, and the characters of its cheek-teeth, the naturalist is led to infer that the macrauchenia was a highly specialised creature; and it is interesting to find that this inference is converted into a certainty by the existence of certain kindred forms in the older formations of the Parana and Patagonia, which are evidently the ancestral types from which the Pampean genus has originated. All these creatures were of relatively small size, with cheek-teeth more closely resembling those of the odd-toed ungulates, and they show a gradual transition in regard to the position of the nostrils from the type of the macrauchenia to the ordinary form. The evolution of such an extraordinary creature as the one under consideration is therefore fully explained, although we have yet to learn the special reason for the peculiar position of its nostrils and the development of a trunk.

More or less intimately allied to the ancestors of the

macrauchenia were certain contemporaneous ungulates from Patagonia, of which the largest did not exceed a tapir in size. With cheek-teeth so like those of the odd-toed ungulates from the Paris basin described by Cuvier as *Palaeotherium*, these Patagonian ungulates differed from the macrauchenia in having the dental series reduced in number and interrupted by gaps. Their most remarkable peculiarity is, however, to be found in the structure of their feet, which, in some forms at least, resembled those of the extinct three-toed horses, or hipparions, in which the middle toe is very large, while the two lateral ones are small and functionless. In one genus, moreover, the toes were reduced to a single large one on each foot, as in the modern horse. And the fact that there existed in South America a group of ungulates which exactly paralleled the horses in the evolution and structure of their feet is one of the most wonderful features in mammalian development.

Among all the extinct mammals of the Argentine, none strike the beholder with more astonishment than those gigantic cousins of the modern armadillos of South America, collectively known as glyptodons, their name being derived from the peculiar sculpture with which the grinding surfaces of their cheek-teeth are ornamented. Both armadillos and glyptodons differ from the other members of the group to which they belong in having their bodies protected by a bony shell, or carapace, covering all but the under-parts, the top of the head being covered by a similar bony shield, while the tail is encased by a series of bony rings, or in rings at the base and a long tube at the tip. Whereas, however, the armadillos (exclusive of the aberrant little pichiciago) have a larger or smaller portion of the middle region of the carapace formed of movable transverse bands

of plates, in the glyptodons the whole structure is welded into a single piece. It must not, however, be supposed that this carapace consists of a single solid dome of bone, as, if it did, there would, of course, be no possibility of growth. On the contrary, the carapace is composed of polygonal or rhomboidal plates articulating at their edges, and thus allowing of free growth. In very old individuals a considerable number of these plates may, however, become completely fused together. During life these bony plates were covered with small horny shields, as in the living armadillos, and they frequently show incised lines formed by the lines of union between such shields. For instance, in the members of the typical genus of the group, or ring-tailed glyptodons, each bony plate was smooth and polygonal in shape, while the lines indicating the borders of the horny shields take the form of a rosette. Another important point of difference from the armadillos is to be found in the contour of the skull, which is short, deep, and rounded, instead of being long, flattened, and pointed at the muzzle. Then, again, whereas the armadillos have small cylindrical teeth, those of the glyptodons are large and fluted at the sides, with their grinding surfaces marked by the aforesaid sculpture; while the whole series is in close contact, and forms one of the most efficient grinding machines imaginable.

To support the enormous weight of the carapace, which in some of the larger kinds is considerably more than an inch in thickness, special modifications are needed in the internal skeleton. Here we find that nearly the whole of the vertebrae are welded together, so that a large portion of the backbone forms a continuous solid tube. The vertebrae of the neck are also very short, and may be partially united, so that the movements of the head must have been

somewhat limited. The observer will not fail to notice also the great strength and upright position of the haunch-bones and the powerful build of the legs and feet, the latter terminating in five toes armed with broad, flattened nails. As an illustration of the various modifications of the same general plan of structure in use in the animal kingdom, it may be well to point out how essentially the arrangement of the armour of a glyptodon differs from that of an ordinary tortoise or turtle. In the latter the carapace is completely welded to the ribs, which are situated externally to the haunch- and shoulder-bones, whereas in a glyptodon there is no sort of connection between the carapace and the ribs, while the latter are internal to the haunch- and shoulder-bones. In these respects the leathery turtle holds a somewhat intermediate position between ordinary turtles and the glyptodons, the carapace being composed of polygonal plates totally unconnected with the ribs, while the latter are situated externally to the bones of the shoulder and haunch.

Not less remarkable are the modifications of the vertebrae of the tail for the support of the rings or tube with which the latter is encased. In the first place, most of the vertebrae of this region are welded together so as to form a hollow, tapering rod, while from each segment are given off radiating processes upon which the bony plates are borne, and as the whole of the latter are firmly welded together, the entire structure is of great strength.

When standing with the edges of its impenetrable carapace resting on the ground, its mail-crowned head partially withdrawn within the front aperture of its shell, and only the lower portions of the limbs exposed, a glyptodon must have been safe from all foes save savage man, and even he must have had a tough job to slaughter the monster,

if, indeed, he ever succeeded in doing so. That man did exist with the later glyptodons, or those which flourished during the deposition of the Pampas mud, is, however, proved by more than one kind of evidence. For instance, crude drawings of these animals have been found incised on some of the rock surfaces of Patagonia, while in other cases human implements have been disinterred side by side with the bones and shells. Probably the empty carapaces of the larger members of the group were employed by the primitive inhabitants of Argentina as huts, and it is said that they are sometimes even so used at the present day by the Indians. That these animals were not killed off by any living foe—either human or otherwise—may be taken for granted, and we must therefore conclude that this result was probably due to the same general cause which brought about the extermination of the larger Argentine mammals. It may be well to mention that, although some of the living armadillos are carnivorous, it is perfectly evident, from the structure of their teeth, that all the glyptodons subsisted exclusively on a vegetable diet.

The earliest known representatives of the group occur in the older Tertiary beds of Patagonia, and may be designated pigmy glyptodons, although known scientifically as *Propalaeohoplophorus*. These creatures, which lived side by side with armadillos nearly akin to existing forms, were the dwarfs of their race, the carapace not being more than a couple of feet in length. The plates of the carapace were smooth, and ornamented with a rosette-like sculpture, of which the central ring in the fore part of the shell was raised into a prominent boss. In the form of these plates, as well as in the circumstances that the tail was surrounded from base to tip with a series of knobbed rings, these pigmy glyptodons resembled the ring-tailed glyptodons of the Pampas, of which

they may accordingly be regarded as the ancestral type. In the intermediate deposits of Monte Hermoso we meet with other glyptodons, which, while much larger than those of the Patagonian beds, were generally inferior in this respect to the giants of the Pampean, some of the species being nearly allied to the small Patagonian representatives of the group, while others belong to the same genera as those found in the Pampas.

Passing on to a survey of the leading types of these creatures found in the alluvial mud of the Pampas, where they occur in great numbers, we may first notice the one to which the name of glyptodon was originally applied. The carapace in this form is characterised by the polygonal plates being nearly smooth and marked by a rosette of incised lines, while those along the margin are raised into a series of bold knobs. In general contour the whole carapace forms a nearly regular oval dome, with the plates on the front and hind margins knobbed and ridged. Although in the specimen first sent to England the tail of another species was unfortunately affixed to the carapace, it is now known that the armour of the tail took the form of a number of rings, gradually diminishing in diameter from the root to the tip, and severally ornamented with a series of conical knobs, thus forming a protective case against which little short of a steam-hammer would have been of any avail.

Although one might have thought that these ring-tailed glyptodons, as they may be conveniently termed, were sufficiently large and *bizarre* to have stood alone in the world, they were exceeded in size and strangeness of form by a still more extraordinary creature. In this stupendous monster, which measured upwards of 11 ft. 8 in. in a straight line, the carapace is characterised by its peculiar hump-

backed form, while its margins lack the prominent knobs characterising those of the preceding group. On closer examination it will be found that each of the component plates of the carapace, instead of being polygonal and marked by a rosette of lines, is rhomboidal and pierced by from two to five large circular holes. From the analogy of the living hairy armadillo—known in Argentina by the name of peludo, or hairy animal—it is quite evident that during life the holes in the plates of the carapace of this extinct monster—which, by the way, may be known as the "club-tailed glyptodon," or technically as *Daedicurus*—must have formed the exits of large bristles, which were equal in diameter to a cock's quill, and were doubtless many inches in length. The whole body of the animal must, therefore, have resembled a gigantic porcupine. Still more extraordinary is the conformation of the huge tail, which had a length of about five feet. At its base this appendage was encircled by about half a dozen double bony rings, nearly as large at the base as the iron hoops in the middle of an ordinary beer-barrel, their component plates being pierced by the aforesaid holes for bristles. The whole of the terminal half of the tail is formed by one continuous piece of hollow bone, which, if we exclude whales, is one of the most massive bony structures in the animal kingdom, and is almost as much as a man can lift. Starting at its base in the form of a nearly cylindrical tube, this sheath rapidly expands at the sides, and becomes flattened on the upper and lower surfaces, until at the tip it finally assumes the form of a depressed, flattened club, which would have formed a most effective weapon for a giant. Along the sides of its extremity this club is marked by a number of oval depressed discs, showing a sculptured pattern of ridges and grooves radiating from the centre, and some

of them attaining a length of six or seven inches. From the structure of their sculpture it seems evident that during life these discs formed the bases of huge horns projecting at right angles to the tail, which would thus have formed a veritable *cheval de frise*. If, as is quite probable, these horns were as long as those of the common African rhinoceros, the tail of the daedicurus must have presented a most extraordinary appearance as it dragged on the ground behind its owner (for it is impossible to believe that any muscles could have raised such a stupendous structure). The use of these horny appendages is, however, hard indeed to guess, since the creature was amply protected by the underlying bone; and it is therefore probable that they must come under the category of ornamental appendages. Be this as it may, with its bristle-clad body and horned tail, the club-tailed glyptodon may well lay claim to the right of being one of the most extraordinary creatures that ever walked this earth during the whole duration of the Tertiary period. Another species belonging to the same genus, of which the remains are found in the Tertiary beds of Monte Hermoso, is remarkable for possessing a cone-shaped aperture in the middle of the hinder part of the carapace, of which the only conceivable use is that it acted as the point of discharge of a gland.

Nearly equal in size to the Pampean representative of the preceding genus, but distinguished markedly by the characters of the skull and the more regularly dome-like form of the carapace, is another monster from the Pampas which has been described under the name of *Panochthus*. Although the plates of the carapace have the same oblong form as in the club-tailed glyptodon, they lack any perforations for bristles, and are marked by a number of

patches of minute tubercles, so that this species may be spoken of as the tuberculated glyptodon. Doubtless the carapace was covered during life by thin horny shields, although the marks of these are not generally shown on the bone; and from the absence of bristles the creature must have been as smooth as the small existing mulita, or three-banded armadillo. The tail was much smaller than that of the club-tailed species, consisting at the base of a number of relatively small rings, and terminating in a tube of about a yard in length. This tube lacks, however, the terminal expansion and flattening of that of the preceding form, while the large discs with which it is ornamented take the form of prominent rough bosses, which probably carried flattened horny knobs, instead of spines, during life.

The last representatives of the group to which I shall allude are much smaller species from the deposits of Monte Hermoso and the Pampas, known as smooth-tailed glyptodons, or, technically, *Hoplophorus*. In these creatures the carapace was much more elongated and depressed than in the other kinds, while it projected forward on the sides of the shoulders in a manner somewhat like that of the armadillos. The plates of the carapace show a rosette pattern, not unlike those of the ring-tailed glyptodon, but they are still smoother, and of an irregular oblong shape. As regards the tail, this consisted at the base of a number of smooth rings, fitting into one another at their junctions like the joints of a telescope, while at the end it terminated in a slightly flattened tube ornamented with a number of small, smooth oval discs of about an inch in diameter, interspersed with which were arranged a few much larger but equally smooth and prominent discs along the sides. These discs, of all dimensions, were evidently coated with smooth scales of horn during life, and, from the absence

of apertures for bristles, the same smoothness doubtless characterised the carapace. The head was protected by a smooth shield of small tesselated plates, and the skull was characterised by the peculiar twisting and curvature of the bones of the nose.

Such are the chief characteristics of the better-known representatives of the mailed monsters of Argentina—a group which was continued in a straight line from the pigmy glyptodon of Patagonia to the ring-tailed species of the Pampas, while all the other giant forms of the latter must be regarded as lateral offshoots from the original stock, which continued, as is so often the case, to develop more and more *bizarre* characters until the date of their final disappearance. In conclusion, it should be added that a strange, gigantic armoured creature, found commonly in the cavern deposits of Brazil, and also rarely in Argentina, seems to have been a kind of connecting link between the glyptodons and the armadillos, having the carapace formed of a number of movable plates, arranged in a series of overlapping bands as in the latter, but with teeth of the type of the former. Unfortunately, however, this interesting creature, which must have been as big as a large rhinoceros, is known by such fragmentary remains that its full affinities cannot yet be determined, as we are still ignorant whether its skull approximated to the glyptodon or the armadillo type.

Sufficiently protected from all attacks on the part of the wolf-like marsupials and such other large carnivorous mammals as may at the same period have roamed over Argentina, the pigmy glyptodon of the Santa Cruz beds of Patagonia could have had no difficulty in maintaining its existence against foes of all kinds, and subsequently giving rise to the gigantic mailed monsters described above.

Side by side with this well-defended creature there lived, however, another not less remarkable mammal, of nearly similar dimensions, and likewise belonging to the great order of edentates, then, as now, so characteristic of South America. This creature had, however, no such coat of mail as that which defended its contemporary (though there is a possibility that some bony granules may have been embedded in its skin), and as it appears to have been equally devoid of weapons of offence, while it did not derive protection from an arboreal life, it may be a matter of wonder how it managed to fight its way through the struggle for existence. That it did so is, however, perfectly clear, since the pigmy ground-sloth, as the animal in question may be called, is clearly the ancestral type from which were subsequently evolved those gigantic edentates of the Pleistocene deposits of the Argentine scientifically known by the names of *Megalotherium*, *Mylodon*, etc., but which may be collectively designated ground-sloths. These, although in some cases unprotected by any means of defence, were among the most gigantic of mammals, and they had, it is needless to say, no difficulty in holding their own; and it is only with regard to their pigmy ancestors that we have any cause for wondering how they managed to survive. Possibly these pigmy ground-sloths were burrowing creatures, like the great ant-eater of the present day, and lived in holes excavated by their powerful claws; and if this should be the case, the difficulty as to their survival vanishes.

Sloths are, however, such essentially arboreal creatures, as characteristic of the Brazilian forests as are squirrels and dormice of our own woods, that my readers will want to know what I mean by using such an apparently contradictory term as ground-sloths.

To justify myself, and at the same time to enable my readers properly to understand the structure of these strange extinct edentates, it is necessary to enter into a short dissertation on the subject of sloths, and likewise of their distant cousins the ant-eaters.

The external form and long shaggy hair of the sloths are too well known to require description, and I pass on to draw attention to certain peculiarities in regard to their skeletons and teeth which will aid in explaining the reason for the term ground-sloths. In the first place, then, sloths, which are comparatively small animals, are characterised by their peculiarly short and rounded heads, of an almost spherical form. If the skull of one of these animals be examined, a total absence of front teeth will be noticed; while the cheek-teeth comprise five pairs in the upper and four in the lower jaw.

As already stated, the teeth in all edentates are devoid of the enamel so characteristic of those of other mammals; and in the sloths they form short cylinders, of which the outer layer is harder than the central core, in consequence of which their grinding surfaces become slightly cup-shaped. In the three-toed sloths (*Bradypus*) the whole of the teeth are of this extremely simple type; but in their two-toed cousins (*Cholaepus*) the first pair in each jaw are longer than either of the others, and modified into a somewhat tusk-like form, the upper ones wearing against the front of the lower ones so as to produce by mutual attrition an oblique bevelled surface at the top of each. Both limbs of sloths are remarkable for their length and slenderness, but the front pair are much longer than the hinder ones. The narrow and curved feet terminate in long hooked claws, which in the three-toed species are three in number in each foot, although in the fore-feet of

the two-toed sloth they are reduced to two; in fact, the feet are reduced to the condition of little more than hooks, admirably adapted for suspending the animal back-downwards from the boughs of trees, but forming poor instruments for terrestrial progression. Indeed, when on the ground sloths walk slowly and awkwardly, with the soles of the feet turned inwards, and the weight of the body supported on their outward edges. It is important to notice that in the skeleton of the feet the terminal bones, or those ensheathed in the long claws, are not longitudinally grooved on the upper surface.

The South American, or true ant-eaters, one of which is terrestrial while the other two are more or less arboreal in their habits, are so unlike the sloths that it is difficult to believe they have any near relationship with the latter; and, indeed, were it not for the extinct creatures now under discussion, it would have been very difficult to discover how close the connection between these two groups really is. In place of the short and rounded heads of the sloths, the ant-eaters have the head greatly elongated and very slender, while the thin jaws are totally devoid of teeth, and the tongue is long, cylindrical, and highly extensile. There is, however, some degree of variation in regard to the elongation of the skull, the maximum development occurring in that of the great ant-eater. If possible, a still greater difference obtains in the structure of the feet, the fore-foot of the great ant-eater having five toes, of which the middle one is vastly more powerful than either of the others, while all but the fifth have strong claws. In walking, the extreme outer side and part of the upper surface of the fore-foot are applied to the ground; but in the hind-foot, which has the fourth toe the largest and all the five digits furnished with claws,

the whole of the short sole touches the ground in the ordinary manner. An important difference from the sloths is to be found in the circumstance that the bones of the terminal joints of the feet have a longitudinal median groove on the upper surface at their tips.

With these remarks on some of the leading features of the sloths and ant-eaters, the reader will be in a position to appreciate the peculiarities in the structure of the ground-sloths, and likewise to understand the appropriateness of the name by which they are designated.

Apparently the first of these extinct animals known in Europe was the giant ground-sloth, or *Megalotherium*, of which a nearly complete skeleton was discovered in the year 1789 near Lujan, in the province of Buenos Aires. This skeleton was soon after sent to Madrid, and described by Cuvier in 1798, who gave it the name by which the animal has ever since been known. Cuvier recognised the affinities of the megalothere to the sloths; and other skeletons subsequently obtained from the superficial deposits of Buenos Aires, and which are now in the Museum of the Royal College of Surgeons, the British Museum, and the museums of Milan, Paris, and La Plata, have in their turn served to confirm the general truth of the original determination.

One of the most gigantic of land mammals, measuring somewhere about eighteen feet in total length, the megalothere, although with a more elongated skull, agrees with the sloths in the number of its teeth. In structure, however, these teeth are decidedly different from those of the sloth. In form they are square prisms, with a length of over ten inches, and a diameter of fully an inch and a half. The summit of each tooth carries a pair of transverse ridges, produced by the alternation of vertical plates of different hardness in the tooth itself; and since the teeth are rootless

and grow continuously throughout the life of their owner, this transversely ridged structure is likewise permanent. To contain such enormous teeth, the lower jaw is remarkably deepened in the middle of its length, where it descends suddenly. A long median channel, extending between and in front of the anterior teeth, is evidently for the reception of a large and fleshy tongue, which from its size was probable extensile like that of the giraffe.

If we had only the megalothere to deal with, there might be some hesitation, judging from the skull and teeth (which in the group are the only portions of the skeleton showing sloth-like affinities) in regarding the group of animals to which it belongs as closely allied to the sloths. Fortunately, however, the same Pleistocene deposits of Buenos Aires (to say nothing of the caverns of Minas Geraes, in Brazil) have yielded remains of other and somewhat smaller ground-sloths, known as mylodons, which effectually bridge, in these respects, the gap between the megalothere and the sloths. In these animals the teeth are either cylindrical or triangular in section; and from having a harder external coat, wear in the same cup-shaped manner as those of the latter. Moreover, in some mylodons the front pair of teeth in each jaw have the elongated tusk-like form and oblique wear characterising those of the two-toed sloth, while in others they resemble the hinder teeth, as in the three-toed sloth. We thus have an exact parallelism in this respect among the mylodons to the two genera of sloths; and as their skulls in their more rounded and shorter form, and the absence of a descending expansion in the middle of the lower jaw, are likewise more sloth-like than is the skull of the megalothere, we can have no hesitation in regarding the ground-sloths, so far as cranial characters

are concerned, as closely allied to the sloths. It may be added that the great divergence of the two series of teeth in the mylodon skull indicates the presence during life of a tongue of great width and size. Mylodons had a number of ossicles, like large beans, embedded in the outer surface of the skin; but in the nearly allied glossothere, of which portions of skin covered with long sloth-like hair have been discovered in a cave in Patagonia, nearly similar ossicles were embedded in the inner side of the skin. Strange to say, these ground-sloths appear to have been kept in caves as domesticated animals by the ancient inhabitants of Patagonia.

Thus far I have shown how the ground-sloths are related to the sloths in the characters of their skulls; but other members of the group, known as the scelidotheres (*Scelidotherium*), although still retaining the same number of teeth, present a certain approximation in these respects to the ant-eaters. Thus their skulls, instead of being short and broad like those of the mylodons, are very long and narrow, and have the muzzle much produced in advance of the anterior teeth. Indeed, it would require only a still greater elongation and narrowing of the skull of a scelidothere, coupled with the total loss of the teeth, to produce one very similar to that of an ant-eater.

So far as I am aware, palaeontologists have not yet been able to trace a complete transition from the gigantic ground-sloths of the Pleistocene deposits of Buenos Aires to their diminutive representatives from the older Tertiary deposits of Patagonia, although it is known that some of the species from the intermediate formations were inferior in point of size to their more recent allies. It is, however, very interesting to find that the pigmy ground-sloths of these Patagonian deposits had transversely ridged

prismatic teeth like those of the megalothere, and not the cylindrical or triangular ones of the mylodons and scelidotheres; thus apparently indicating that the former type of tooth is the oldest. The contrast between the pigmy ground-sloth and the giant ground-sloth (*Megalotherium*) is, however, most remarkable. The total length of the skeleton of the former was only about three feet, while its skull was less than six inches, whereas that of the latter was over a couple of feet in length. Then, again, the whole series of five upper teeth occupy in the pigmy ground-sloth a space of less than an inch and a half, or less than the diameter of a single tooth of its gigantic relative. That such a diminutive creature, if as naked and undefended as its huge cousin appears to have been, needed some special protection, is evident; and it is the need of such defence from attack that has led me to suggest that the creature may have been fossorial in its habits.

Leaving for a moment the mutual relationships and affinities of all these different animals, a glance may be directed at the skeleton of the body and limbs of the ground-sloths. In the first place this differs from that of the sloths in the shortness and extreme massiveness of the limbs; and especially in the extraordinary stoutness and width of the bones of the hind-leg and haunches. In the general form of the scapula or blade-bone, and more especially in the presence of a complete pair of clavicles or collar-bones, the ground-sloths resemble the sloths and differ from the ant-eaters; the clavicles of the latter being rudimentary. The skeleton of the fore-foot is, however, essentially that of an ant-eater, the inner toe being rudimentary, the next three, and more especially the middle one, enormously enlarged, and furnished

during life with huge claws, while the outermost was small and clawless. That during life the creature rested on the outer side of this fifth claw and the backs of the three large toes, in ant-eater fashion, may, from the structure and arrangement of their bones, be considered certain. Unlike the ant-eater, in which it rests upon the sole, the hind-foot of the Pleistocene ground-sloths is even more strangely modified than the front one, these creatures walking only on its outer edge, while the enormous middle toe, with its gigantic claw, does not appear to have touched the ground in walking, and was thus always kept sharp. The first toe is wanting, and the second rudimentary, while the two outer ones were relatively small and unprovided with claws. Some idea of the gigantic proportions of the megalothere may be gathered from the circumstance that its hind-foot measures nearly a yard in length. Of the pigmy ground-sloths of Patagonia the complete skeleton has not yet been described; but so far as my recollection of a specimen in the La Plata museum goes, I believe that it was not of the extremely specialised type characterising the later gigantic forms. Moreover, while in the latter the terminal joints of the feet were neither grooved nor split at the extremities, in the small Patagonian species these were deeply cleft at the end, as in the scaly ant-eaters or pangolins of India and Africa. As regards the structure of the vertebral column, the ground-sloths exhibit certain peculiarities distinctive of the ant-eaters, which are only rudimentary in the sloths.

When to this brief survey of the chief structural peculiarities of the skeleton of the creatures under consideration is added the circumstance that, from their enormous size, they must necessarily have been terrestrial in their

habits, we are in a position to realise the appropriate nature of the term "ground-sloths" by which they are designated. These creatures may, in fact, be briefly described as edentates with a skull, teeth, and shoulder-girdle very similar to those of the sloths; while as regards their backbone and feet they come very close to the ant-eaters, although in the later and more gigantic forms the specialisation characterising the fore-feet of the latter has been extended to the hinder pair.

Turning to the question of the mutual relationships and phylogeny of the three groups of edentates discussed in the course of the foregoing paragraphs, we shall have little hesitation in regarding the pigmy ground-sloths, which are the earliest known representatives of the group, as the direct ancestors of the gigantic megalothere. A modification in the structure of the teeth would equally well permit of their having likewise been the ancestors of the mylodons, which, as we have seen, possess sloth-like teeth. This, however, will not permit us to regard the mylodons as having been the forerunners of the sloths, seeing that the latter have a less specialised type of hind-foot; and we must accordingly regard the sloths as a side branch derived from the pigmy ground-sloths or some nearly allied forms after the acquisition of cylindrical teeth, but before the hind-foot had acquired the specialisation characterising the mylodons and megalotheres. Hence the curious structural similarity between the front teeth of some of the mylodons and the two-toed sloth must be another instance of that parallelism in development to which reference has so often been made.

With regard to the ant-eaters, we have already seen that the fore-foot of these animals resembles that of the pigmy ground-sloths in that the terminal joints of the

larger toes are marked by a longitudinal groove representing the cleft of those of the latter; and as in both groups the middle toe is the largest, there is no reason why the ant-eaters should not trace their origin to these same pigmy ground-sloths or a closely allied type. In this case the specialisation has resulted in a lengthening of the skull and the loss of the teeth, the hind-foot having retained more or less of the primitive type. Here likewise we must notice that the resemblance presented by the skull of the scelidotheres to that of the ant-eaters must be regarded as an instance of parallel development.

From the structure of their teeth, the ground-sloths were evidently pure vegetarians; and the same may be said of the sloths, which are animals specially modified for the exigencies of an arboreal existence. On the other hand, the ant-eaters, as their name implies, have given up a vegetable diet and taken to living on ants, and to this may be attributed their total loss of teeth. Should germs of teeth ever be found in their jaws during an early stage of existence, I venture to predict they will approximate in structure to the teeth of the ground-sloths.

I cannot conclude without saying a few words as to the probable mode of life and external appearance of ground-sloths. The Patagonian specimens have shown that, like sloths and ant-eaters, they were clothed with a thick covering of coarse hair. Further, from their massive proportions, and also from their kinship to the sloths, it is most likely that ground-sloths were as slow and deliberate in their movements as the latter. That such monstrous creatures could not have existed in a treeless country like the Argentine Pampas has been already pointed out, and we may hence assume that in the days of the ground-sloths Argentina was much like what Brazil is at

the present day. Browsing on the leaves and perhaps the smaller branches of forest-trees, the ground-sloths probably obtained their food by rearing themselves up against the trunks, supported on the tripod formed by their massive hind-limbs and powerful tail, the ponderous structure of the haunch-bones being eminently adapted for maintaining the body in such a posture. The same massiveness of structure conclusively proves that the creatures were not arboreal, since no tree capable of being climbed could carry such an enormous weight. It was suggested, indeed, by Sir Richard Owen that the megalothere was in the habit, when reared up in the manner indicated above, of clasping a tree in its arms and swaying it backwards and forwards until it fell with a crash to the ground; but although such a radical mode of procedure may have been occasionally resorted to, we have no right to assume that such was the ordinary habit of the ground-sloths.

CELEBES: A PROBLEM IN DISTRIBUTION

PROBABLY at least nine out of every ten of the readers of the present article would pronounce the name of the island Celebes with the second syllable short; and if it were an English name, they would be right in so doing. But the Malays have a habit of accenting the middle syllable of three-syllabled words, and we thus have Saráwak, Basílan, Celébes, etc. In this respect Malay names are the exact opposite of South American, in which the accent falls on the third syllable, as in Panamá, Bogotá, and Ecuadór. Doubtless it is a small matter, but it is well to be correct even in the pronunciation of names.

Having put matters right in this respect, the next point is to inform my readers why Celebes has been selected as the subject of an article at all; and why Borneo, Sumatra, or Java would not have done just as well. To render this point clear I must refer briefly to the geographical position of Celebes and the neighbouring islands. Borneo, Sumatra, and Java are the three largest of the Malayan islands lying nearest to the Malay Peninsula; and although they possess many peculiar animals—notably the orang, which is confined to Borneo and Sumatra—yet their fauna as a whole is very similar to that of the Malay mainland, and thus intimately connected with that of India. Accordingly, naturalists are pretty well agreed in including these islands in what is called the Oriental region of

zoological distribution, of which the Philippine Islands likewise form a part.

Now, Celebes lies due east of Borneo, from which it is separated by the Macassar Strait, and also nearly midway between the Philippines on the north and the small islands of Lombok, Sumbawa, and Flores on the south; these three latter islands forming the continuation of the line of Sumatra and Java, which evidently indicates an old peninsula. Eastward of Celebes lie the Moluccas (or Spice) Islands on the north, and Ceram (which forms the lowest member of the same group) in the south; both these being nearly midway between Celebes and Papua or New Guinea. And when we reach the latter country we are practically in Australia, the animals being quite unlike those of the typical Malayan islands and the other countries of the Oriental region. We have, for instance, in New Guinea, tree-kangaroos, cuscuses, flying-phalangers, bandicoots, echidnas or spiny ant-eaters, cassowaries, cockatoos, birds of paradise, and bower-birds, all of which are essentially Australian types, although some, like the birds of paradise, attain their maximum development in New Guinea itself. The little island of Ceram has also a fauna of an Australian type, including, among other forms, a cassowary. Accordingly, all naturalists are agreed that Australia, New Guinea, Ceram and the other Moluccas, together with the Aru and some of the other small islands in the neighbourhood, form one great zoological province, which may be called the Australasian. But the problem has been in which region to place Celebes, whose fauna is in some respects intermediate between that of the Australasian and Oriental regions. By Dr. A. R. Wallace, the great authority on the geographical distribution of animals, it was at first classed with the former, although

subsequently given a doubtful position; and his views have been followed by most later writers. Recently, however, several writers have come to the conclusion that it should be included in the Oriental region.

A glance at the map will show that Celebes is an island of very peculiar and unusual shape. It consists of an irregular central region, from which are given off four still more irregular peninsulas, of which the one running in the direction of the Moluccas is considerably the largest. Its general outline is more like that frequently assumed by an amoeba than anything else, and it is quite clear from this remarkable shape that the island is situated in a subsiding area, and once formed a portion of a much larger land-mass. From the peculiarity of its animals it is evident that Celebes has existed as an island since an epoch comparatively remote; and the question naturally arises whether its last connection was with Borneo and the other Malay islands, or with Ceram and New Guinea. In a question of this nature the depth of the surrounding seas has, of course, a most important bearing.

Putting, however, the evidence of soundings on one side, we may endeavour to find out how much light the animals of Celebes are capable of throwing on the problem.

Those of my readers who have any acquaintance with the geographical distribution of animals, are probably aware that no marsupials at all are found to the westward of Celebes, and that to the eastward of that island monkeys are quite unknown; while hoofed animals are represented only by a deer in Timor and a second in the Moluccas, and likewise by a semi-wild pig in Ceram and another in New Guinea. In fact, the quadrupeds of the Australasian region, with these exceptions, consist exclusively of egg-laying mammals, marsupials, and various peculiar kinds of

rats, mice, and bats; while, as already said, their birds include cassowaries, cockatoos, birds of paradise, bower-birds, and a host of other kinds more or less completely unknown in the regions to the westward.

But, unfortunately, there is another element in the problem which introduces a further complexity. The Malays are bold and clever sailors, fond of voyaging from island to island in these summer seas. And they are also wonderful adepts in taming animals of various kinds. Many of these they carry about with them in their voyages—some probably for food and others as pets. When they land on a strange island some of these animals may occasionally escape, or possibly may be turned loose intentionally. Now there is a very considerable probability that the wild pigs of Ceram and New Guinea have been thus introduced; and if this be the case, the fauna of the Australasian region is made more absolutely distinct from that of the Oriental province. The deer of the Moluccas and Timor present a case of greater difficulty; but as the Moluccas cannot well be separated from the Australasian region, they would seem, in these islands at least, to have been introduced, and, if so, the same will hold good with regard to certain smaller mammals of an Oriental type, such as civets.

We are now in a position to consider how the animals of Celebes compare with those of the neighbouring islands. Now, the only mammals of a purely Australian type found in that island are two species of cuscuses—sleepy creatures, with beautifully soft fur, often very brilliantly coloured, and showing great individual or sexual variation in the markings. They are near relatives of the so-called opossums (phalangers) of Australia, and are entirely arboreal creatures, passing the day comfortably coiled up in slumber

and feeding at night. If these creatures were of a type near to that from which the other marsupials of Australia have sprung, they might be considered as survivors from a migration of marsupials which it has been suggested took place at a remote epoch from Asia to Australia. But they are not so, and it is therefore clear that this hypothesis will not account for their presence in the island. As they are so completely arboreal in their habits, they are, however, just the kind of creatures which we might naturally expect to be wafted from one island to another on floating timber; and it is far from improbable that it is to this mode of transport they owe their presence in Celebes.

All the other mammals are of an Oriental type, although several of them are quite unlike their relatives on the mainland and other islands. Among them one of the most remarkable is the babirusa, a curious little pig in which the tusks of both jaws in the males attain a most extraordinary development, the lower ones rising straight upwards, while the upper ones grow right through the skull to curve backwards in a bold sweep towards the eyes. Although nothing definitely is known as to the origin of this strange animal, yet it is evidently a highly specialised offshoot from the ancestral pigs of Asia. Equally peculiar is the tiny little black buffalo, or anoa, described in another article, which is not much larger than a good-sized ram, and has upright horns quite unlike those of the ordinary Asiatic buffalo. In the island of Mindanao, the most southern of the Philippine group, there is, however, a considerably larger buffalo, known as the tamarao, which serves to connect the anoa with the ordinary Asiatic species. More important still is the occurrence in the Tertiary deposits of Northern India of several species of buffaloes intimately related to the anoa. Clearly, then, this animal

has originated from an Oriental stock, and the occurrence of an allied species in the Philippines tends to show that these islands were connected at no very remote epoch with Celebes. Now the Philippines themselves, as shown by their deer, have intimate relationships with Borneo, and thus with the mainland.

The deer reported to occur in the island is a variety of the rusa of Java, and apparently identical with the form found in the Moluccas. It is generally considered to have been introduced, but as Celebes shows so many signs of affinity with the more western Malay islands in its animals, this does not by any means appear certain. Anyway, the Moluccan race may well have been exported from Celebes by the Malays.

The next most noteworthy animals in the mammalian fauna of the island are two species of monkeys, both remarkable for their black colour. The first of these is the short-tailed black baboon, a species representing a genus by itself, but with relationships to the true baboons of Africa and South-West Asia. Such relationship, from a geographical point of view, might seem difficult to account for, and to those who neglect the animals of a past epoch it would appear well-nigh inexplicable. But it happens that extinct baboons occur in India; and as they doubtless also existed in other parts of the Oriental region, there is no difficulty in accounting for the origin of the Celebesian representative of the group. The other species—the moor macaque—belongs to a widely spread Oriental genus.

But the most curious of all the mammals of the island is a species of tarsier—small creatures with enormous goggle eyes, slender, lanky limbs, and toes terminating in suckers, distantly related to the lemurs. Now, these tarsiers are strictly limited to the islands of Sumatra,

Borneo, Java, Celebes, and Mindanao, together with some of the neighbouring islets, and are totally unknown to the eastward of the Molucca Sea. Although, being arboreal animals, it may be argued that, like the cuscuses of Celebes, they may have been carried about by floating timber, yet it seems in the highest degree unlikely they should have reached all the islands with an Oriental type of fauna and avoided all those where the true Australian type comes in. Moreover, they are very delicate animals, exceedingly difficult to keep alive in captivity, and there is accordingly a strong probability that they are native to the islands where they occur. Like so many of its other animals, the tarsier of Celebes is black—as, indeed, are the species from the other islands.

So far, then, as their mammals are concerned, it seems probable that at no very distant epoch Celebes, Borneo, and the Philippines formed one land area; while Borneo itself was connected with the mainland, probably by way of Sumatra, the orang and some other species being common to these two islands and unknown elsewhere. It is further probable that Celebes, and most likely a portion of the Philippines, became isolated before Borneo ceased to be connected with Sumatra—or at all events with the mainland. Possibly this early separation may account for a very curious difference between the fresh-water fishes of the two areas; Celebes having no carps (*Cyprinidae*) or cat-fishes (*Siluridae*), both of which are abundant in Borneo, as in Asia generally. With regard to the south-western portion of the Philippine group, it is important to notice that the island of Palawan shows evidence of a closer connection with Borneo than with the rest of the archipelago to which it belongs. On the other hand, the mountains of Luzon, in the Northern Philippines, are the home of

a remarkable group of rats, some of which show affinity to those inhabiting Australia; and it therefore seems highly likely that the Philippines mark a portion of the line by which Asia was probably in communication at a still earlier epoch with New Guinea and Australia. Still, there are some difficulties in this view of the case, because the more primitive types of marsupials now found in Australia are at present unknown in New Guinea. Possibly, however, some still remain to be discovered in the unexplored mountains of that country; while, since the exploration of the Luzon Mountains by the late Mr. John Whitehead yielded such wonderful zoological results, there is the possibility that when the mountains of the other islands have been as carefully worked we may find a few marsupials still surviving. Should such a fortunate "find" turn up we should have much support to the view that the ancestors of the present fauna of Australia travelled from Asia by way of the eastern archipelago.

There are many other points connected with the present distribution of animal life in this wonderful region, and their bearing on the former relations of the various islands to one another, to which the limits of this article forbid reference. A word may, however, be said in reference to Timor, which, as already mentioned, forms the eastern extremity of the line of the Sunda Islands—that is to say, the line including Sumatra, Java, and Flores, which is evidently a broken-up peninsula. By most writers that portion of the chain lying to the eastward of Java and Bali has been assigned to the Australasian region, and it has consequently been assumed that the deer found in Timor must have been introduced by man. Timor and Flores also contain several other mammals common to the Oriental region, notably a monkey, a civet, a porcupine,

and a palm-civet; and although it is quite possible that they may have been introduced by the Malays (as some of them appear to have been into the Moluccas), the absence of any typically Australasian mammals except a cuscus (whose presence may be accounted for in the same way as in Celebes) is, to say the least, very remarkable. Moreover, the birds of Timor show at least as many Oriental as Australasian features, and it accordingly seems more consonant with the known facts to regard the whole chain of the Sunda Islands, which are geographically one, as having formed a part of the old Asiatic continent.

Possibly my readers may think I have written a very dull and uninteresting article, and that it is a matter of very little importance indeed what were the former relations of a number of obscure Malay islands. And in one sense this is undoubtedly the case. But all those who have once essayed the study of the distribution of animals cannot fail to be fascinated by the problems it presents; and in no case are these problems more difficult to solve than in the eastern islands of the Malay Archipelago. As evidence of the interest attaching to Celebes, I cannot do better than conclude by an extract from Dr. Wallace's "Island Life."

"There is no other example," it is written, "on the globe of an island so closely surrounded by other islands on every side, yet preserving such a marked individuality in its forms of life; while, as regards the special features which characterise its insects, it is, so far as is yet known, absolutely unique. Unfortunately, very little is known of the botany of Celebes, but it seems probable that its plants will to some extent partake of the speciality which so markedly distinguishes its animals; and there is here a rich field for any botanist who is able to penetrate to the forest-clad mountains of its interior."

A DROWNED CONTINENT

A FEW years ago deep boring operations were undertaken in the island of Funafuti, in the Ellice group of Polynesia, with the primary object of ascertaining the depth to which coral-rock, or limestone of coral origin, extends. As it was found that such coral-made material extended to depths far below the level at which living coral can exist, evidence was afforded that the island had subsided. And as subsidence was thus proved to have taken place in a single island selected almost at random, the conclusion could hardly be resisted that the greater part, if not the whole, of Polynesia must likewise be a subsiding area, or, in other words, the remnants of a drowned continent, some of the higher lands of which are indicated by the atolls and other islands of the Coral Sea. This raises the whole question as to the permanence or otherwise of the great oceanic basins and continental areas of the globe: a subject, it need scarcely be said, having not only an intense interest of its own, but also one of the utmost importance in regard to many puzzling problems connected with the present and past geographical distribution of terrestrial animals and plants on the surface of the globe.

Although it might well have been thought that opinion in scientific matters would be unlikely to veer suddenly round, and after tending strongly in one direction incline with equal force in the one immediately opposite, yet

there are few instances where the swing of the pendulum of opinion to one side has been more swiftly followed by its oscillation to the other than has been the case in the problem of the permanency of continents and oceans. When geology first began to take rank among the exact sciences, and it was demonstrated that most of the shells and other fossils found in the solid rocks of many of our continents and islands were of marine origin, it was a natural, if hasty, conclusion that land and sea had been perpetually changing places, and that what is now the centre of a continent might comparatively recently have been an ocean abyss. Accordingly, when any difficulty in finding an adequate explanation in regard to the geographical distribution of the animals or plants of two or more continents or islands occurred, the aid of an "Atlantis" or a "Lemuria" was at once invoked without misgiving, and a path thus indicated across which the inhabitants of one isolated area could easily have passed to another.

This was one swing of the pendulum. But as the methods of geological observation and investigation became more exact and critical, it was soon obvious that, in many areas at least, the alternations between sea and land could not have been so frequent or so general as had been at first supposed. It was, indeed, perfectly true that many portions of some of our present continents had for long periods been submerged, or had been at intervals alternately land and sea. But at the same time it began to be realised that the fossiliferous marine deposits commonly met with on continents and large islands were not of such a nature that they could have been laid down in depths at all comparable to those now existing in certain parts of the basin of the Atlantic. Even a formation like our

English chalk, which had been supposed to have analogies with the modern Atlantic deposits, appears to have been laid down in a sea of much less depth and extent, and probably more nearly comparable with the modern Mediterranean. Then, again, it was found that large tracts in some of our present continents, such as Africa and India, had existed as dry land throughout a very considerable portion of geological time. Moreover, it was asserted that no formations exactly comparable to those now in course of deposition in the ocean abysses could be detected in any of our existing continents or islands; while it was further urged that in none of the so-called oceanic islands (that is, those rising from great depths at long distances from the continental areas) were there either fossiliferous or metamorphic rocks similar to those of the continents and larger continental islands.

This was the second swing of the pendulum, and for a long period it was confidently asserted that where continents now exist there had never been any excessive depth of ocean; and, conversely, that in the areas now occupied by the great ocean abysses there had never been land during any of the later geological epochs. It was, indeed, practically affirmed that wherever the sounding-line indicates a thousand fathoms or more of water, there sea had been practically always, and that no part of the present continents had ever been submerged to anything like that depth.

Almost as soon as the pendulum of opinion had attained the full limits of its swing in this direction (and this swing had been largely due to the influence of geologists and physicists), there began to be signs of its return to a less extreme position. It was, in the first place, proved that a few deposits—and these of comparatively recent date—

analogous to those of the ocean abysses do occur in certain areas. And, in the second place, it was shown that a few oceanic islands do contain rocks like those of the continents, and are not solely of volcanic or organic origin. Zoological and palaeontological discoveries were at the same time making rapid advances; and the students of these branches of science, who had been among the foremost in giving the swing of the pendulum on the side of continental instability its first impulse, now began to press their views—only in a more moderate manner—in the same direction. Evidence had long been accumulating as to the identity of certain fresh-water formations and their included animal and plant remains occurring in South America, South Africa, India, and Australia; and it was urged that during the Secondary period of geological history not only was Africa connected with India by way of Madagascar and the Seychelles, but that land extended across what is now the South Atlantic to connect the Cape with South America, and that probably India was likewise joined to Australia by way of the Malay Archipelago and islands. In fact, there seems good evidence to indicate that at this early epoch there was a land girdle in comparatively low latitudes encircling some three-fourths of the earth's circumference from Peru to New Zealand and Fiji.

Even taking into account its comparatively early date, the existence of this girdle of land, the evidence in favour of which can scarcely be shaken, gave a heavy blow to the adherents of the absolute permanency of continents and oceans, as it clearly indicates the relatively modern origin of the basin of the South Atlantic. But this is not all: South America, which, as mentioned in an earlier article, was once more or less completely cut off from the northern half of the New World, shows certain indications of affinity

in its fauna with that of Europe in early Tertiary times, and to a certain extent with that of modern Africa; and the most satisfactory way of explaining these relationships is by assuming either the persistence of a land connection between the Cape and South America across the South Atlantic till a comparatively late geological epoch, or that such connection took place farther south by means of the Antarctic continent. There are several objections, which need not be considered here, in regard to the latter alternative, and since there is other evidence in favour of the comparatively recent origin of the South Atlantic depression, the persistence of a land connection in lower latitudes seems the more probable explanation.

In addition to all this there are indications of a relationship between the land faunas of Australasia and South America; and as similar types are not met with in Africa, and several of them belong to groups unlikely to have endured Antarctic cold, it has been suggested that America and Australasia were in connection at no very remote epoch by way of the Coral Sea. It is known, for instance, that some of the Australian marsupials are more or less closely allied to others which inhabited South America before it was connected with North America; and as no kindred types are met with either in the latter area, in Europe, or in Africa, a land connection by way of the South Pacific, and that at a comparatively recent epoch, offers almost the only satisfactory explanation of the means of transit, if the Antarctic theory be rejected. And it may be mentioned in passing that the acceptance of even the latter would imply a large modification from the existing distribution of land and water in the southern hemisphere. Similar evidence is afforded by certain extinct tortoises common to South America and Australia.

But the evidence for a land connection by way of the Pacific does not by any means rest on the testimony of marsupials and tortoises alone. Passing over certain groups, it may be mentioned that the earthworms of Australia and New Zealand are strangely like those of Patagonia, and have no very near relatives in Africa; while an almost equally strong affinity is stated to exist between the Patagonian and Polynesian land-slugs. Neither of these groups of animals are fitted to withstand the cold of high latitudes, and it is difficult to see how the members of the second, at any rate, could have reached the two areas by any other means than a direct land connection.

Turning to the reports of the Funafuti boring, it appears that this has been carried far below the limits of coral life, and was still in coral limestone. So far, therefore, the advocates of the theory that Polynesia is the remains of a sunken continent have scored a great triumph; and although there is still the possibility that some of the atolls in this vast area may prove to be perched on the denuded summits of extinct submarine volcanoes, even this would not interfere with the general conclusion. If deeper borings should result in touching rocks more or less similar to ordinary continental sedimentary deposits or metamorphic crystallines, an even firmer basis would be afforded to the hypothesis of subsidence which has now received such striking confirmation.

As the result of the boring, it appears, then, that there is a possibility that the community between the South American and Australasian faunas may admit of being explained by means of a direct land connection between the two areas at a comparatively recent geological date. Even, however, if this explanation receive future support and acceptation, there are, as in all similar cases, still

many difficulties with which to contend. One of these is the practical absence of all non-volant mammals from Polynesia, with the exception of the Solomon group, where a few cuscuses and rats are found. But the case of the West Indies—where there is every probability that there was formerly a large mammalian fauna, the majority of which were drowned by submergence—may very likely afford the solution of the difficulty. Worms and slugs would probably find means of survival in circumstances where mammalian life would disappear. This explanation will, however, clearly not apply in the case of New Zealand, where, if mammals had ever existed, their remains would almost certainly have been discovered. It must be assumed, then, that if Polynesia was the route by which the faunas of Australia and Patagonia were formerly connected, New Zealand was at that time isolated. And, indeed, seeing that the presumed land connection between the areas in question must have existed at a comparatively late epoch, it is most likely that the ancient Polynesian land was already broken up to a considerable extent into islands and archipelagos, so that the main line of communication may have been but narrow, and from time to time interrupted. Indeed, it must almost of necessity have been very incomplete and of short duration after the introduction of modern forms of life, as otherwise the types common to Australia and Patagonia would have been much more numerous than we find to be the case. Hence there is no improbability in the suggested isolation of New Zealand during the period in question.

But, putting these interesting speculations aside, the results of the Funafuti boring indicate almost without doubt that Polynesia is an area of comparatively recent subsidence, and it has already been mentioned that there

are good reasons for regarding a large part of the basin of the South Atlantic as of no great antiquity, while the area of the Indian Ocean seems to have been considerably enlarged during the later geological epochs. Apparently, therefore, the great extent of ocean at present characteristic of the southern hemisphere is a relatively modern feature.

Hence it is clear that the extreme views prevalent a few years ago as to the absolute permanency of the existing continental and oceanic areas stand in need of some degree of modification. And what we have now to avoid is that the pendulum should not once more take too long a swing in the opposite direction.

So far as the great continental masses of the northern hemisphere are concerned, it would appear that portions of these have always existed to a greater or lesser extent as land. But the great extent and homogeneous character of formations like the Mountain Limestone, the Chalk, and the Nummulitic Limestone, suggest that sea was much more prevalent in this area than it is at present, and that, so far as the Old World is concerned, the continental area has been growing. The North Atlantic, and probably also the North Pacific, may apparently be regarded as basins of great antiquity. On the other hand, in the southern hemisphere, although Africa, parts of Australia, and at least some portions of South America, are evidently land surfaces of great antiquity, they, together with the islands of the Coral Sea, seem to be mere remnants of a much more extensive southern continent or continents. Conversely the southern oceans have gained in area by swallowing up these long-lost lands. Obviously, then, although true in a degree, continental permanency has not been the only factor in the evolution of the present surface of the globe.

DESERTS AND THEIR INHABITANTS

If popular errors connected with matters scientific are hard to kill, still more is this the case when the erroneous opinions have been held by scientists themselves. The idea that flints and other stones grow is, I have good reason to believe, still far from extinct among the non-scientific, and it is not improbable that there are persons possessing some acquaintance with science who still cherish the belief that deserts are uninterrupted plains of smooth sand, originally deposited at the bottom of the sea, from which they have been raised at a comparatively recent epoch. At any rate, there are several books, published not very many years ago, in which it is stated in so many words that the Sahara represents the bed of an ancient sea, which formerly separated Northern Africa from the regions to the southward of the tropics.

As a matter of fact, these opinions with regard to the origin and nature of deserts are scarcely, if at all, less erroneous than the deeply ingrained popular superstition as to the growth of flints and pudding-stones. And a little reflection will show that the idea of the loose sands of the desert being a marine deposit must necessarily be erroneous. Apart from the difficulty of accounting for the accumulation of such vast tracts of sand on the marine hypothesis, it will be noticed, in the first place, that desert-sands are not stratified in the manner characteristic of

aqueous formations; and, secondly, even supposing that they had been so deposited, they would almost certainly have been washed away as the land rose from beneath the sea. Then, again, we do not meet with marine shells in the desert-sands, of which at least some traces ought to have been left had they been marine deposits of comparatively modern age.

Whether or no the subjacent strata have ever been beneath the ocean, it is absolutely certain that the sands of all the great deserts of the world have been formed *in situ* by the disintegration of the solid rocks on which they rest, and have been blown about and rearranged by the action of wind alone. All deserts are situated in districts where the winds blowing from the ocean's surface have to pass over mountains or extensive tracts of land, which drain them more or less completely of their load of moisture. Hence, in the desert itself, when of the typical kind, little or no rain falls, and there is consequently no flow of water to wash away the débris resulting from the action of the atmosphere on the rocks below.

In other words, as has been well said, desert-sands correspond in all respects, so far as their mode of origin is concerned, to the dust and sand which accumulate on our high roads during a dry summer. On our highways, indeed, the summer's dust and sand are removed by the rains of autumn and winter, only to be renewed the following season; but in a desert no such removal takes place, and the amount of sand increases year by year, owing to the disintegration of the solid rock here and there exposed.

Only one degree less untrue than the idea of their submarine origin is the notion that deserts consist of unbroken tracts of sand. It is true that such tracts in certain districts may extend on every side as far as the

eye can reach, and even much farther; but sooner or later ridges and bands of pebbles, or of solid rock, will be met with cropping up among the sand, while frequently, as in the Libyan Desert, there are mountain ranges rising to a height of several thousand feet above the level of the plain. And it is these exposed rocks which form the source whence the sand was, and still is, derived. These mountains naturally attract what moisture may remain in the air, and in their valleys are found a more or less luxuriant vegetation. Oases, too, where the soil is more or less clayey, occur in most deserts; and it is in such spots that animal and vegetable life attains the maximum development possible in the heart of the desert.

In the most arid and typical part of the Libyan Desert the sand is blown into large dunes, which are frequently flat-topped, and show horizontal bands of imperfectly consolidated rock; and between these are open valleys, partly covered with sand and partly strewn with blocks of rock polished and scored by the sand-blast. In such sand-wastes the traveller may journey for days without seeing signs of vegetation or hearing the call of a bird or the hum of an insect's wing. But even in many of such districts it is a mistake to suppose that vegetable and animal life is entirely absent throughout the year. In the western Sahara, for instance, showers generally moisten the ground two or three times a year; and after each of these a short-lived vegetation springs suddenly up, and if no other form of animal life is observable, at least a few passing birds may be noticed.

Among the most important and extensive deserts of the world we have first the great Sahara, with an approximate area of sixteen thousand square miles, nearly connected

with which is the great desert tract extending through Arabia, Syria, Mesopotamia, and Persia. By means of the more or less desert tracts of Baluchistan, Sind, and Kuch, this area leads on to the great Rajputana Desert of India. More important is the vast Gobi Desert of Mongolia, and other parts of Central Asia. In Southern Africa there is the great Kalahari Desert, of which more anon. In North America there is a large desert tract lying east of the Rocky Mountains, and including a great part of Sonora; while in the southern half of the New World there is the desert of Atacama, on the borders of Peru and Chili. Lastly, the whole of the interior of Australia is desert of the most arid and typical description.

But among these there are deserts and deserts. Tracts of the typical barren, sandy type are, as already said, extensively developed in the Sahara, as they are in the Gobi and the Australian deserts. Between such and the plains of the African veldt there is an almost complete transition, so that it is sometimes hard to say whether a given tract rightly comes under the designation of a desert at all. A case in point is afforded by the South African Kalahari. Although there are endless rolling dunes of trackless sand, and rivers are unknown, yet in many places there is extensive forest, and after a rain large tracts could scarcely be called a desert at all. Mr. H. A. Bryden, for instance, when describing the Kalahari, writes as follows: "And yet, during the brief weeks of rainfall, no land can assume a fairer or more tempting aspect. The long grasses shoot up green, succulent, and elbow-deep; flowers spangle the veldt in every direction; the giraffe-acacia forests, robed in a fresh dark green, remind one of nothing so much as an English deer-park; the bushes blossom and flourish; the air is full of fragrance;

and pans of water lie upon every hand. Another month and all is drought; the pans are dry again, and travel is full of difficulty." During the grassy season herds of springbok used to migrate in the old days to the Kalahari, in the northern part of which giraffes live the whole year, although they must exist without tasting water for months.

Although such a district can scarcely be termed a desert in the proper sense of the word, yet its sands have precisely the same origin as those of deserts of the typical description.

For sand to accumulate to the depths in which it occurs in many parts of the Sahara and the Gobi by the slow disintegration of the solid rocks under the action of atmospheric agencies must require an enormous amount of time, to be reckoned certainly by thousands, and, for all we know, possibly by millions of years. And we accordingly arrive at the conclusion that the larger desert tracts must not only have existed as land for an incalculable period, but also as desert. Hence we can readily understand why the animals of Algeria and the rest of Northern Africa differ for the most part from that portion of the continent lying to the south of the northern tropic, the Sahara having for ages acted as an impassable barrier to most, if not all.

But if other evidence were requisite, there is another reason which would alone suffice to compel us to regard deserts as areas of great antiquity. The habitable parts of all deserts—and it is difficult for the inexperienced to realise that barren tracts will suffice for the maintenance of animal life—are the dwelling-places of many animals whose colour has become specially modified to the needs of their environment. And it will be quite obvious

that such modifications of colour, especially when they occur in animals belonging to many widely sundered groups, cannot have taken place suddenly, but must have been due to very gradual changes as the particular species adapted itself more and more completely to a desert existence.

To obtain an idea of the type of coloration characteristic of the smaller desert animals, the reader cannot do better than pay a visit to the Natural History branch of the British Museum, where, in the Central Hall, he will find a case devoted to the display of a group from the Egyptian desert, mounted, so far as possible, according to their natural surroundings.

Among such animals may be mentioned the beautiful little rodents respectively known as jerboas and gerbils, together with various birds, such as sand-grouse, the cream-coloured courser, the desert-lark, desert-finches, and desert-chat, and also various small snakes and lizards, among the latter being the common skink. Although some of the birds retain the black wing-quills of their allies, in all these creatures the general tone of coloration is extremely pale, browns, fawns, russets, olives, greys, with more or less of black and pink, being the predominant tones; and how admirably these harmonise with the inanimate surroundings one glance at the case in the Museum is sufficient to demonstrate. Very significant among these are the desert-finches (*Erythrospiza*), which belong to the brightly coloured group of rose-finches, one of these specially modified species ranging from the Canaries through the Sahara and Egypt to the Punjab, while the second is an inhabitant of the Mongolian desert.

Among larger animals, a considerable number of the gazelles are desert-dwellers, these including the palest-

coloured members of the group; and lions are likewise to a great extent inhabitants of deserts—as, indeed, is true of tawny and pale-coloured animals in general.

All the animals above mentioned belong, however, to widely spread groups, which are common to the desert tracts of both Africa and Asia, and they do not, therefore, serve to prove the antiquity of any particular desert, as they or their ancestors might have (and probably did) migrate from one desert to another. Birds of such groups are, of course, even more untrustworthy than mammals, owing to their power of flight. And among those referred to, some, such as the sand-grouse, can scarcely claim to be regarded as exclusively desert birds, since they are partial to any open sandy plains, like those of the Punjab, or even Norfolk.

The case is, however, very different with certain of the larger mammals, a notable instance being afforded by the antelopes allied to the South African gemsbok (*Oryx*). All the members of this group are inhabitants of more or less sandy open districts, and never range eastwards of Arabia, or possibly Bushire. The gemsbok itself, together with the beisa of Eastern and North-eastern Africa, are inhabitants of districts which do not, for the most part, come under the designation of typical deserts. And we accordingly find that both are by no means very pale-coloured animals, while both are remarkable for the bold bands of sable ornamenting their face and limbs. On the borders of the Sahara there occurs, however, a very different member of the group—the sabre-horned oryx (*O. leucoryx*)—differing from the others by its curving horns, and likewise by the extreme pallor of its coloration, which is mostly dirty white, with pale chestnut on the neck and under-parts. Obviously this species has been specially

modified as regards coloration for the exigencies of a purely desert existence, and as it is also structurally very different from all its existing kindred, it must clearly be looked upon as a very ancient type, which commenced its adaptation to the surroundings of the Sahara ages and ages ago. The Arabian desert is the home of another species of oryx (*O. beatrix*), which, although more nearly allied to the East African beisa, is a much smaller and paler-coloured creature. In this case also there would seem little doubt that the period when this animal first took to a purely desert existence must have been extremely remote.

But an even more striking instance is afforded by another antelope remotely connected with the gemsbok, which is an inhabitant of the Sahara and the Arabian desert, and is commonly known as the addax. It is an isolated creature, with no near relation in the wide world, and is easily recognised by its dirty white colour, shaggy mane, and long twisted horns. It must have branched off at a very remote epoch from the gemsbok stock, and affords almost conclusive evidence of the antiquity of the deserts it inhabits, as we have no evidence of the occurrence of allied extinct species in other countries.

Some degree of caution is, however, necessary in drawing conclusions that all isolated desert animals have been evolved in the precise districts they now inhabit. A case in point is afforded by the saiga, a pale-coloured antelope without any very near kindred, inhabiting the steppes of Eastern Russia and certain parts of Siberia, where it is accompanied by the hopping Kirghiz jerboa (*Alactaga*). Now, since fossilised remains of both these very peculiar animals have been discovered in the superficial deposits of the south-eastern counties of England, it is a fair inference that physical conditions similar to those of the steppes

(which, by the way, are by no means true deserts) obtained in that part of our own country at an earlier epoch of its history. From their comparatively isolated position in the zoological system, as well as from their occurrence in the strata referred to, both these desert animals evidently indicate very ancient types, and they accordingly serve to show not only that the semi-desert steppe area formerly had a much greater western extension than at present, but probably also that the existing portion of that area dates from a very remote epoch. Hence they confirm the idea of the early origin of the present deserts of the Old World and their inhabitants.

It will be gathered from the foregoing that the deserts and steppes of Africa and Asia possess a large number of animals belonging either to species which have no very near living relatives, or to altogether peculiar genera. In the Arizona Desert of the Sonoran area of North America it seems, however, to be the case that its fauna is largely composed of animals much more nearly related to those inhabiting the prairie or forest-lands of the adjacent districts, of which, in many cases at any rate, they constitute mere local races distinguished by their paler and more sandy type of coloration. This is well exemplified by the mule-deer, which in the Rocky Mountains is a comparatively dark and richly coloured animal, but becomes markedly paler on the confines of the Arizona Desert, assuming again a more rich coloration when it reaches the humid extremity of the Californian peninsula. Most of the North American mammals, indeed, acquire similar pale tints as they reach the Arizona desert-tract, and a practised naturalist can pick out with comparative ease the specimens coming from this area from those of the moister districts.

It is not easy to obtain information as to the physical features of the Arizona Desert as compared with the Sahara, and especially as to the amount of sand it contains area for area; but, judging from the comparatively slight modifications which its mammals appear to have undergone as compared with those of the more humid regions adjacent, it seems not unlikely that these deserts are of more modern origin than the Sahara and the Gobi.

Whether or no it be true in this particular case, it may be laid down as a general rule that the greater the amount of sand to be found in a desert, and the greater the difference between the animals inhabiting that desert from those dwelling in the adjacent districts, the greater will be the antiquity of the desert itself. In the case of a desert forming a complete barrier across a continent, like the Sahara, if the animals on one side are quite different from those on the other, its antiquity will be conclusively demonstrated. If, on the other hand, they are more alike, the age of the desert will be proportionately less.

AFRICA AND ITS ANIMALS

If we take a map of the world, and, after tracing upon a sheet of thin paper the outline of the British Islands, cut out the tracing and lay it upon India, we shall find that it covers a mere patch of that great area. Repeating the same process with India, and placing the tracing thus obtained on Africa in such a manner that the sharp angle on the tracing formed by Assam overlies the projecting point of Somaliland, which it almost exactly covers, it will be found that the whole area embraced in the tracing occupies only a small patch in the middle of the eastern side of the Dark Continent. As a matter of fact, the patch thus marked out ends in a blunt point northwardly some distance above Khartum, thence it runs south to the neighbourhood of the Victoria Nyanza, from which district it rapidly narrows to terminate in a sharp point a little distance to the southward of Zanzibar. Allowing some slight overlaps, no less than six Indias can indeed be traced on the map of Africa; and as these leave between them and on their margins considerable spaces of the country still uncovered, it would be but a moderate estimate to say that Africa includes at least seven times the area of British India. Some idea, especially to those familiar with our vast Indian dominions, may in this manner be most readily gained of the huge extent of the African continent.

Having made these comparisons of the actual size of the

three areas under consideration, I must ask my readers to regard them for a moment from another point of view. Every one familiar with the birds and mammals of the British Isles is aware that, even excluding Ireland, the same species are not found over the whole area. The Scottish hare, for instance, is specifically distinct from the ordinary English kind; while the red grouse is unknown in the southern and eastern counties of England, and the ptarmigan is confined to the colder districts of Scotland. These are accordingly indications that even such a small area as the British Isles contains local assemblages of animals, or faunas, differing more or less markedly from those of other districts.

Turning to India, we find such local faunas—as might be expected from its larger area—more distinctly defined, and more markedly different from one another. One great fauna occupies the southern slopes of the Himalaya from their base to about the upper limit of trees; this fauna, which includes many peculiar types unknown elsewhere, being designated the Himalayan. The second, or typical Indian fauna, occupies the whole of India, from the foot of the Himalaya to Cape Comorin, exclusive of the Malabar coast, but inclusive of the north of Ceylon. The third, or Malabar fauna, occupies the Malabar coast and some of the neighbouring hills, together with the south of Ceylon; the animals of these districts being very different from those of the rest of India. The fourth, or Burmese fauna, embraces only the province of Assam, in what we commonly term India; and many of its animals, again, although of the general Oriental type, are very different from those of the other districts. But even such divisions by no means give the full extent of the local differences between the animals of the whole area. In the second or typical area,

for example, the creatures inhabiting the open districts of the Punjab and the North-West Provinces display remarkable differences from those dwelling in the forests of Southern India (the home of the strange loris); while the dwellers in the jungly tract of the south-western districts of Bengal are equally distinct from those of either of the other areas.

Seeing, then, that while slight differences are observable in the local faunas of such a small area as the British Islands, and that much more important ones characterise the different zoological provinces of the vastly larger extent of country forming British India, it is but natural to suppose that distinctions of still higher value would be characteristic of different parts of Africa, accordingly as they differ from one another in climate, and consequently in vegetable productions.

As a matter of fact, such differences do occur to a most marked degree; but when the vast superiority of Africa over India is taken into consideration, the marvel is that the fauna of the greater part of that area is not more dissimilar than it is, and that it has been found possible to include the more typical portion of the continent in one great zoological region or province.

But the reader will naturally inquire what is meant by calling one portion of a continent more typical than the rest. As has been pointed out in the last article, Northern Africa has, so far as its animals are concerned, been cut off from the districts lying south of the Tropic of Cancer by the great barrier formed by the Sahara; and as the animals of the districts to the north of that desert are for the most part of a European type, while Southern Europe and Northern Africa were evidently joined by land at no very distant epoch of the earth's history, the districts north of

the Sahara are for zoological purposes regarded as part of Europe and Asia. Typical, or Ethiopian Africa, as it is more generally termed, includes, therefore, only such portion of the continent as lies to the south of the northern tropic.

But some critical reader may perhaps be led to remark that some at least of the animals of Northern Africa are common to the south; the lion, whose range extends from Algeria to the Cape, affording a case in point. To this it may be replied that, popular prejudice notwithstanding, the lion cannot in any sense be looked upon as a characteristic African animal. Although year by year growing rarer, it to this day still lingers on in certain parts of Western India, while it is likewise found in Persia and Mesopotamia, and within the historic period was common in South-Eastern Europe. At a still earlier epoch, as attested by its fossilised remains, it was an inhabitant of our own island. It may, therefore, to a certain degree be regarded as a cosmopolitan animal, which may have obtained entrance into Africa by more than one route. In a minor degree the same may be said of the hippopotamus, which was formerly found in the lower reaches of the Nile, and at a much earlier epoch in many parts of Europe, inclusive of Britain. Being an aquatic animal, it can avail itself of routes of communication which are closed to purely terrestrial creatures.

Of the fauna of typical Africa, as a whole, some of the most striking features are of a negative nature; that is to say, certain groups which are widely spread in most other districts of the Old World are conspicuous by their absence. This deficiency is most marked in the case of bears and deer, neither of which are represented throughout the whole of this vast expanse of country. Pigs allied to the wild swine of Europe and India are likewise lacking, their place

being taken by the bush-pigs and the hideous wart-hogs, both of which are among the most characteristic of African animals. Except for a couple of species of ibex in the hills of the north-east, sheep and goats are likewise unknown in a wild state. Among other absentees in the fauna, special mention may be made of marmots, and their near allies the susliks, as well as of voles, beavers, and moles.

Of the mammals (and space permits of scarcely any reference to other groups) which may be regarded as characteristic of typical Africa as a whole, the following, in addition to the bush-pigs and wart-hogs already mentioned, are some of the most important. Among the monkeys the most widely distributed are the hideous baboons (*Papio*), now restricted to Africa and Arabia, the southern portion of the latter country being included in the same great zoological province. The guenons (*Cercopithecus*), species of which are the monkeys commonly led about by organ-grinders, have also a wide distribution on the continent, although of course more abundant in the forest regions than elsewhere; and the guerezas (*Colobus*), one of which is described in a later article, have also a considerable range. In a totally different group, the curious little jumping-shrews (*Macroscelides*) form a peculiarly characteristic family of African mammals belonging to the insectivorous order. There are also many peculiar genera of mongooses, but as most of these have a more or less local distribution, they can scarcely be considered characteristic of the continent as a whole; still, they are quite different from those found elsewhere. A very curious carnivorous mammal known as the aard-wolf (*Proteles*), strikingly like a small striped hyaena, is not the least peculiar among the animals of Africa, where it has a comparatively wide range. The hunting-dog (*Lycaon*), which presents a considerable

resemblance to the spotted hyaena, is an equally remarkable representative of the dog family. Although formerly found in Europe, the spotted hyaena itself is now exclusively African.

Passing by the rodents, or gnawing mammals, as being less familiar to non-zoological readers, we have the two species of hippopotamuses absolutely confined to Africa at the present day; we are all familiar with the common species in the "Zoo," but the small West African kind, which has more the habits of a pig, is much less commonly known.

The stately giraffes are solely African, but are mainly confined to more or less open districts; while their ally the okapi is a forest species. The herds of antelopes, for the most part belonging to generic types unknown elsewhere, with the exception of a few in Arabia, form one of the most distinctive features of African life. Many of them, like the strange gnus and the graceful gemsbok group, are confined to the open districts of the south and east; but others, such as the bush-bucks and the harnessed antelopes, have representatives in the forest districts of the west. Both species of African rhinoceros are quite different from their Oriental relatives; but only one of these, the common species, has a wide distribution in the country. Zebras and the extinct quagga are familiar and striking African animals, although most of them are confined to the open plains and mountains. On the other hand, the African elephant, which differs so widely in the structure of its teeth from its Asiatic relative, has a much more extensive distribution, and may therefore be classed among the most characteristic of Ethiopian animals. Even more peculiar are the little dassies (*Procavia*), the miscalled coneys of our version of the Bible, which form a family absolutely peculiar to Africa, Arabia, and Syria; some of the species dwelling among rocks, while others are active climbers, and

From a photograph by Lord Delamere.]

AFRICAN ELEPHANTS.

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frequent the forest districts. But perhaps the strangest mammal that may be regarded as characteristic of Africa as a whole is the aard-vark (*Orycteropus*), commonly known to the colonists as the ant-pig. It is a strangely isolated creature, having at the present day no near relations, either poor or otherwise.

The African buffaloes, with their several races or species, also belong to a type quite peculiar to the continent. To a great extent the ostrich is characteristic of Africa and Arabia, although there is evidence to show that it formerly enjoyed a considerable range in parts of Asia.

The above are only a few of the more striking instances showing how different are the animals of Africa as a whole from those of the rest of the world. Many others might be added, but they would only weary my readers. Of course, there are many groups, like the cats, common to other countries, the lion and the leopard being found alike in Africa and India; but such do not detract from the peculiarity of the African fauna as a whole. And here it may be mentioned that a large proportion of the types now peculiar to the Dark Continent once had a much wider geographical range, fossil remains of baboons, giraffes, hippopotamuses, ostriches, antelopes of an African type, and not improbably zebras, having been discovered in the Tertiary deposits of India.

But if the animals of Africa as a whole stand out in marked contrast to those of the rest of the world, much more is this the case when those characteristic of certain districts of that huge continent are alone taken into consideration. And most especially is this the case with the inhabitants of the great tropical forest districts extending from the west coast far into the interior of the continent—reaching, in fact, the watershed between the basins of the

Congo and the Nile in the neighbourhood of Wadelai. As a large number of the peculiar animals of this district are more or less exclusively confined to the west coast, extending from Sierra Leone to the Congo, the area is appropriately termed the West African sub-region. It is here alone that we find the gorilla and the chimpanzee, the former being restricted to the neighbourhood of the coast, whereas the latter ranges far into the heart of the continent. And this district is likewise the exclusive home of the pretty little mangabeys, or monkeys with white eyelids (*Cercocebus*). The galagos, which are near relatives of some of the lemurs of Madagascar, extend throughout the forest region; but the even more curious pottos, or thumbless lemurs, are confined to the west coast. Huge and forbidding fox-bats, some of them with remarkable tufts of long white hairs on the shoulders, are likewise restricted to this portion of the tract, as is the insectivorous otter, or *Potamogale*, first discovered during the travels of Du Chaillu. The equatorial forest-tract is also the sole habitat of the African flying-squirrels, to which further reference is made in the sequel; all these being distinguished from the flying-squirrels of Asia by the presence of a number of scales on the under-surface of the tail. Most of them belong to the genus *Anomalurus*, but the smallest of all forms a genus (*Idiurus*) by itself, while a flightless type (*Zenkerella*) also belongs to the group. Dormice of peculiar types and tree-mice are also very characteristic of this tract. But far more generally interesting are the pigmy hippopotamus of Liberia and the water-chevrotain (*Dorcatherium*) of the west coast, the latter an ally of the chevrotains of India and the Malay countries. So far, indeed, as the equatorial forest tract fauna has any representative in other parts of the world, it is to the Malay Peninsula and its islands that the resemblance is

closest. It is there alone that the other large manlike ape—the orang—dwells; and there is a group of brush-tailed porcupines common to these two districts, and unknown elsewhere throughout the wide world. Both faunas, however, in all probability trace their descent from the animals inhabiting Europe during the Pliocene and Miocene epochs, among which was an extinct species of water-chevrotain. As already mentioned, the okapi is restricted to the forest area, as is the beautiful white-striped bongo antelope, and its much smaller relative the zebra-antelope.

The other great sub-regions include the open grazing grounds and mountains of South and East Africa, the fauna of which is quite different from that of the equatorial forest-tract. Minor divisions may also be recognised in this area, the Cape having many animals not found farther north. Among the latter are the extinct quagga, the pretty little meerkat (*Suricata*), and the Cape sand-mole (*Bathyergus*), which, by the way, has nothing to do with the true moles, being a member of the rodent order. The tract as a whole may be termed the east central sub-region; and to it belong the great hosts of antelopes, the zebras, and the aard-wolf and hunting-dog. Very characteristic of the southern and eastern parts of this tract are the beautiful golden moles (*Chrysochloris*), unique among mammals for the lovely play of iridescent colours on the fur, and which have nothing in common with the moles of Europe and Asia. To the northward, in Abyssinia, this tract is the home of another very remarkable animal, the great gelada baboon (*Theropithecus*), easily recognised by the lionlike mantle of long hair on the forequarters, whose nearest relative is the Arabian baboon.

Whether Somaliland should be included in this area, or

should have a division to itself, may admit of argument; but at any rate it has many peculiar animals, among which are a number of antelopes.

Lastly we have the Saharan sub-region, which contains a comparatively limited fauna, passing by almost insensible degrees into that of Northern Africa.

In some respects, especially in its galagos, the fauna of Africa presents a certain resemblance to that of Madagascar; but the connection between that island and the mainland was evidently very remote, and must apparently have taken place before the great incursion of antelopes, zebras, rhinoceroses, monkeys, elephants, etc., from the north, as none of these are found in the island. Madagascar, therefore, is best regarded as forming a zoological province by itself.

Within the limits of a single article it is manifestly impossible to give anything like an adequate sketch of the fauna of such an extensive area, but such points as have been noticed serve to show in some faint degree its richness in peculiar forms of animal life.

It may be added that North-Eastern Africa has an extinct mammalian fauna of its own, which seems to include the ancestors of the elephant tribe.

MONKEY HAND-PRINTS

THE arrangement of the fine ridges and grooves on the palmar aspect of the human hand has of late years been studied with great attention—first by Sir Francis Galton, and subsequently by Mr. Henry, now Chief Commissioner of the Metropolitan Police—in order to develop a satisfactory system of identification by means of "finger-prints." That exceedingly important and interesting subject is not discussed in the present article, in which attention is restricted to the arrangement of these lines on the hands of monkeys, and their function in both men and monkeys. This study seems to have been first seriously taken up by Dr. D. Hepburn, of Dublin, who communicated to the Dublin Society the results of his investigations, which were duly published in the *Transactions* of that Society. The method employed by Dr. Hepburn was to take impressions of the hands of living monkeys on plates of glass coated with printers' ink; but there are many difficulties connected with this operation, and in preparing a series of impressions for the Natural History Museum, it occurred to me that I might be able to take them on paper from the hands of monkeys recently deceased. I accordingly communicated with the Prosector to the Zoological Society, asking him to be good enough to send me the right hands of some of the monkeys that died in the Society's menagerie. With this request he very kindly complied, and from the specimens which from

time to time arrived at the Museum, I was enabled to take, among others, the impressions herewith reproduced. Although they are not quite so successful as might be desired, they are yet amply sufficient to show the general plan of arrangement of their lines, and the variation to which they are subject in different genera. Enlargements from these same impressions are now exhibited in the British (Natural History) Museum.

Before proceeding farther I must disclaim any intention of poaching on the preserves of the so-called science of "palmistry." This, so far as I can understand its methods, deals exclusively with the folds or creases on the human palm (corresponding with the white lines in the annexed figures); while attention is here concentrated on the mode of arrangement of the raised ridges and their intervening grooves. It may, however, be mentioned that the creases in question have, both in man and monkeys, a definite mode of arrangement, which appears to be due to the position and action of the palmar muscles. What possible connection there can be between such muscular creases and the duration of human life or the vicissitudes of our mortal career may well be left for the professors of palmistry to explain as best they can.

As regards the structure of the palmar ridges, an examination of the reader's own hand with a lens will easily show that these consist of a series of very minute cone-like elevations, placed close together, and on the summits of which are situated the apertures of the sudoriferous or sweat-glands. If a section of the skin be examined under a microscope, it will also be evident that within these papillae are certain organs of touch know as the tactile bodies. Between the papillary ridges, as we may term them, are situated the equally narrow

MONKEY HAND-PRINTS.

A.—Right Palmar Imprint of a Macaque Monkey (*Macacus cynomolgus*); *a*, *b*, *c*, interdigital eminences; *d*, radial eminence; *e*, ulnar eminence.
B.—Right Palmar Impression of a Spider Monkey (*Ateles ater*).
C.—Right Palmar Imprint of a Marmoset (*Hapale jacchus*).
D.—Right Palmar Imprint of a Red-fronted Lemur (*Lemur rufifrons.*)

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grooves, which contain neither sweat-glands nor tactile bodies.

Looking carefully at fig. A in the plate, and, if necessary, employing a lens, it will be seen that the arrangement of the ridges and grooves, instead of being uniform over the entire palm, takes the shape of a series of definite patterns in certain areas, between which a more or less regular linear arrangement obtains. On the ball of each finger and the thumb, for example, it will be noticed that the ridges assume what may be termed a concentric pattern, in which the central ridges run longitudinally. Again, on the three eminences situated on the palm opposite the clefts between the four fingers, they take the form of concentric whorls (*a*, *b*, *c*). A similar radial eminence (*d*) with a whorl-like pattern is situated opposite the cleft between the thumb and the forefinger; while yet another whorl-bearing elevation (*e*), which may be termed the ulnar eminence, has its position at the basal angle of the palm opposite the little finger. Minor eminences, with much less distinct patterns, also occur on the palmar surfaces of the two basal joints of the fingers. Between these various pattern-bearing eminences, as is especially well shown on the fingers, the ridges and grooves tend to arrange themselves either in transverse lines, or (in the words of Dr. Hepburn) with such slight modification of this direction as would place them parallel to the long axis of any cylindrical object which might be grasped by the foot. It may be added that although in the human hand the patterns found on the balls of the fingers are frequently more complex than those in the monkey's hand, yet the converse of this is true with regard to the eminences on the palm itself, the ulnar whorl being generally quite obsolete in man.

In ordinary five-fingered monkeys, whether they hail from the Old World or from the New, the foregoing type of eminences is very constant. This is well exemplified by the impression of the hand of one of the South American capuchin monkeys (fig. A). Here, however, the fingers are much longer and more slender than in the Old World macaque. In consequence of this the bulbs of the fingers are much less developed, so that it was found impossible to get a good impression of them. These features are even more developed in the hand of the tiny American marmosets (fig. D), in which the digits are more like claws than fingers, and consequently afford only a narrow and blurred impression. A peculiarity of the marmoset hand-print is to be found in the circumstance that the radial eminence has come up to form an arch with the three interdigital elevations, and that the ulnar elevation and pattern are obsolete. Seeing how comparatively wide apart from one another (both zoologically and geographically) are the ordinary monkeys of the Old and New Worlds, it is not a little remarkable that the palm-print of the macaque should be so strikingly like that of the capuchin.

This similarity (since everything in nature has a use) suggests that the patterns on the hands of these two monkeys are due to the same physiological cause; and we have now to inquire what that cause is. The best clue to the problem seems to be afforded, somewhat strangely, by the tails of such of the South American monkeys as are endowed with prehensile power in those appendages; confirmatory evidence being likewise afforded by the prehensile tails of the American opossums and tree-porcupines, as well as by those of the Australian phalangers. In all these animals the naked, grasping portion of the tail, which is situated at the extremity, is

covered with papillary ridges and grooves precisely similar to those on the hands and feet of monkeys, but invariably arranged in simple transverse lines across the tail, so that in the act of grasping they would be parallel to the long axis of the branch around which the tail was coiled. Clearly, then, papillary ridges are primarily connected with the grasping power, and when they are intended solely for that function, they are so arranged as to be parallel to the axis of the object grasped. As regards this function of the papillary ridges, Dr. Hepburn observes that although they are comparatively low, "yet they must cause a certain amount of friction, and thereby prevent slipping, while the naturally moist and clammy condition of the palm and sole of monkeys must be of material assistance to the firmness of the grasp. A man instinctively moistens the palms of his hands when he wishes to make his grasp more secure; and the grasping power of monkeys must be considerably increased by the application of the numerous papillary ridges which are capable of intimate adaptation to the surface of the object grasped."

In a later passage the same observer adds that, apart from the hook-like manner in which the orang-utan and the American spider-monkeys employ their hands in trapeze-like movements, there can be no doubt that the palms are capable of a considerable amount of lateral folding, as is proved by the creases to which allusion has been already made. And it appears probable that the papillary ridges are designed to afford increased firmness of grasp when the palms are thus folded. Consequently, simple transverse ridges on the palms, except in the second joints of the fingers, are conspicuous by their absence; and we find instead the complicated patterns on the eminences already described.

lemur, or a modification thereof, obtains in all the true lemurs, must wait the acquisition of additional fresh specimens of the hand; but in that species at all events it seems certain that these pads have a kind of sucker-like action, which must greatly increase the firmness of their owner's hold on the boughs it grasps.

Apparently this type of palm-structure culminates in the curious little tarsier of the Malay Islands, in which the long and slender toes terminate in round sucker-like discs; similar discs occurring on the toes of the hind-foot. Unfortunately I have had no opportunity of taking the palm-impression of a recently deceased tarsier, and it will probably be long before such a chance occurs, so that I can say nothing as to the mode of arrangement of the papillary ridges.

It may be added that the finger- and toe-pads of those curious lizards commonly known as geckos are likewise modified into adhesive discs. But in this case the sucking action is caused by the skin being raised into a series of parallel plates, and as palmar eminences, as well as papillary ridges, are wanting, the structure is not apparently strictly comparable with what obtains in the tarsier and the lemurs.

But even the foregoing by no means exhausts the subject of palmar and plantar eminences. Any one of my readers who takes the trouble to examine the feet of a cat, a dog, or a rabbit will find a number of bare elevated pads, covered with rough granular skin, interspersed among the generally hairy surface. In all cases, both in the fore and hind limb, one of these bare pads will be found occupying the lower surface of the terminal joint of each toe, lying immediately below the claw. And it will be quite obvious that these correspond to the pattern-bearing eminences occupying the balls of the thumb and

fingers of the monkey. In regard to the pads on the palm and sole, these are subject to some degree of variation in the carnivora, and they may sometimes coalesce to such a degree that their original relations are more or less obscured. But in some of these animals * three distinct pads are observable in the forefoot corresponding in position with the interdigital eminences of the monkey's palm. Continuing the semicircle formed by these three is a fourth pad, representing the radial eminence of the monkey, while farther down on the palm is one corresponding to the ulnar eminence of the latter; a small additional pad being intercalated between the radial and the ulnar pads.

It is thus fully demonstrated that the pads on the forefoot of the dog and the cat correspond with the pattern-bearing eminences of the monkey's palm, and these again with the much less distinctly defined eminences on the human hand. In animals which use both feet exclusively for walking, it will, however, be obvious that delicate papillary ridges, designed partly for the purpose of obtaining a firm grip on any object seized, and partly to act as organs of touch, would be perfectly useless. And we accordingly find the papillary ridges of man and monkeys replaced in the cat, the dog, and the rabbit by granular conical elevations, which have, however, doubtless the same structure, and are foreshadowed by the pustules on the fingers and palms of the lemurs.

One other point remains to be mentioned. In all the lower monkeys that have been examined both by Dr. Hepburn and myself the pattern of the papillary ridges

* Those who are interested in the subject may turn to the figure of the foot-pads of the Linsang, given by the late Prof. Mivart on p. 158 of the *Proceedings* of the Zoological Society for the year 1882.

is of the concentric type (as shown in fig. A), in which the central ridges are longitudinal and the external ones form broad ellipses. In the chimpanzee, however, and probably also in some or all of the other manlike apes, the pattern on the balls of the fingers is of the form known as the looped type, which is of common occurrence in the fingers of the human hand. On the finger-tips of man alone occurs the still more complicated whorled type; and it is thus evident that even in such a minute detail as the arrangement of the lines on the fingers the manlike apes and man stand apart from their kindred, and that in man alone is the most complicated type ever developed, although even in him it is comparatively rare.

LIVING MILLSTONES

THE mill-like action of their own upper and lower molar-teeth upon one another may have been quite sufficient to suggest to our prehistoric parents the idea of opposing a pair of corrugated stones in such a manner that by mutual rotation or revolution they should be capable of reducing to powder hard substances placed between them. Indeed, the idea of millstones is such a simple and natural one that it is quite probable it may have occurred to the human mind without any reference to any prototype in nature; and in any case, if such a natural prototype is to be sought, it is not necessary to go farther in search of it than our own dental organs. Excellent, however, for their special purpose as are these organs (when not subject to premature decay), there are other types of tooth-structure to be met with in the animal kingdom which present a much closer approximation to millstones, and might well have foreshadowed these instruments, had they only been accessible to the primeval savage. But since these natural millstones occur only in marine fishes, some of which inhabit distant seas, while others are met with only as fossils deeply buried in the rocks, it is evident that the idea of artificial millstones is not derived from these natural prototypes. In other words, to use an expression now fashionable in natural science, the development of artificial and natural millstones is a case of parallelism.

In spite of the fact that their early ancestors were provided with a good working set of sharply pointed dental organs, birds in these degenerate days manage to get along without teeth at all. A few mammals, too, like the South American ant-eaters, are in the same condition; and some people have thought that in a few more generations civilised man himself will be reduced to the same toothless state. The great majority of mammals, however, possess a more or less efficient set of teeth, varying in shape, size, and number according to the need of each particular species or group. But there is one feature common to these organs in mammals of all descriptions; and this is that they are strictly confined to the margins of the jaws, never extending either on to the palate, or to the space enclosed between the two branches of the lower jaw. In many reptiles, such as crocodiles and a large number of lizards, the same law of dental arrangement obtains. In some lizards, and still more markedly in certain extinct members of the reptile class, we find, however, a number of teeth developed on the palate, having flattened crowns, and thus tending to make the mouth act the part of one large millstone. But we must descend a stage farther in the scale of animated nature before we come to structures which are strictly comparable with artificial millstones and crushing cylinders. And it is in the class of fishes that we meet with these organs in the full perfection of this type of development. Not that they occur by any means in all the groups of that class; the fact being that at the present day living millstones are going out of fashion, the great preponderance of modern fishes having their dental armature mainly restricted to the margin of the jaws, with or without a minor development of crushing teeth on the palate or the bones of the gullet. With the exception of a comparatively limited number of cases, showing a different type of develop-

ment, to which it is not my present intention to allude, these dental millstones are confined at the present day to those hideous marine fishes commonly known as skates and rays, and to the singular Port Jackson shark and a few allied species inhabiting the Pacific and Malayan seas. On the other hand, the seas of the Cretaceous, Jurassic, and antecedent epochs absolutely swarmed with numerous kinds of sharks more or less nearly related to the Port Jackson species, whose mouths were filled with pavements of teeth showing marvellous variety of structure and beauty of ornamentation. The skates and rays, too, displayed types of dental millstones quite unlike any of those of the present day. And in addition to these, there were hosts of enamel-scaled fishes whose mouths were likewise crammed with beautiful crushing teeth, albeit of a totally different type of structure to that obtaining in either the sharks or the rays. Although well-nigh extinct, these enamel-scaled fishes are still represented by the bony pike of the rivers of North America and the bichir (remarkable for its fringed fins and the row of finlets down its back) of tropical Africa. But it is noteworthy that in neither of these survivors of an ancient group do we find the mouth furnished with an apparatus of millstones; while, as already said, among the host of sharks that infest the warmer seas of the globe it is only in the Port Jackson species and its three kindred that we find similar structures retained; all the other members of the group having developed cuspidate teeth adapted for seizing and tearing soft-fleshed prey, instead of for grinding-up mail-clad food.

Clearly, then, there has been some general cause at work which has rendered crushing teeth, so to speak, unfashionable among the fishes of the present day and the immediately antecedent epochs. And in this connection it is

important to notice that there has been an even more strongly marked tendency to the extinction of the enamel-scaled fishes, and their replacement by the ordinary soft-scaled fishes so abundant in the present seas. As the majority of these old mail-clad fishes, as well as a large proportion of the ancient sharks, were provided with crushing teeth, it is a fair inference that their food consisted largely of shell-fish and crustaceans, with a certain proportion of their own mail-clad relatives. When, however, the swift-swimming, soft-scaled fishes came to the fore, they would naturally offer a more tempting and nourishing diet to such sharks and other predaceous members of their own class as were swift enough in their movements to make them their prey. And consequently the old millstone-jawed sharks would tend more or less completely to disappear. On the other hand, the skates and rays, which are for the most part slow-moving creatures, flapping sluggishly along on the sea-bottom by means of their fan-like fins, would be quite unable to capture the modern type of swift-swimming fish. And they have thus had to content themselves with the old-fashioned diet of shell-fish and crabs, in consequence of which a large proportion of them have retained the dental millstones which have been so steadily going out of fashion among their more advanced relatives. Not that these rays and skates have by any means been content with the kind of molar machinery that did duty for their forefathers, since some of them, together with their Tertiary ancestors, have developed what appears to be an absolutely perfect type of living mill, far superior to that which served the purpose of their predecessors. And it must always be remembered that these beautiful living millstones and cylinders (which are some of the most exquisite bony structures to be met

with in the whole animal kingdom) excel their artificial substitutes in that they never wear out; being renewed either by the development of new teeth on the inner or hinder aspect of the cylinder, or by vertical successors replacing the individual teeth from below or above.

And now that the dental millstones of the rays have been mentioned, it will afford a convenient starting-point for a brief survey of some of the most remarkable types of structure presented by these curious organs.

The teeth of rays always form a pavement-like structure, of which the component elements are arranged in straight longitudinal rows, although they sometimes likewise show a quincunxial mode of arrangement. The individual teeth are not replaced by vertical successors; but, being in the form of a half-cylinder, as those in front become worn down, the whole series is pushed forwards, and new teeth are developed on the hinder margin of the cylinder. The supreme development of a dental structure adapted for crushing in this group occurs in the family of the eagle-rays (*Myliobatidae*), in which the millstone of each jaw forms a perfect semi-cylinder or plate, made up of flat-crowned prismatic teeth united at their edges, often so as to constitute a mosaic-like pavement. No piece of modern machinery can be better adapted for crushing hard substances than are these beautiful ivory cylinders and plates, the crushing power of which, when worked by the strong jaws, must be enormous, and sufficient to grind the strongest shell that can be introduced between them to powder. Although in all cases pavement-like, the millstone differs considerably in the different species in its structure.

As an illustration of the group, we may take one of the millstones of the beaked eagle-rays (*Rhinoptera*). Here the

millstone is in the form of a semi-cylinder, consisting of five or more rows of teeth; a very usual number being seven. Generally the teeth of the middle row are the widest; those of the rows on either side being considerably narrower, while the two or three marginal rows on each side may be compared to the tesserae in a mosaic pavement. A further development of the same type is exemplified by the typical eagle-rays (*Myliobatis*), in which the middle row of teeth in the millstone becomes still wider, while the three lateral rows on each side are reduced to the condition of hexagonal tesserae. Moreover, whereas in the species of *Rhinobatis* both millstones are in the form of half-cylinders, in *Myliobatis* the upper one alone retains this form, the lower being a flattened plate. The culmination of this type of sculpture is displayed in the rays belonging to the allied genus *Aëtobatis*, in which both upper and lower millstones are flat and composed only of the middle row of teeth, which are of great width; the lateral rows having completely disappeared. The existing representative of this genus is not very large (for a ray), seldom, if ever, measuring more than about five feet across; but some of its extinct predecessors must have been monstrous fish, as the teeth measure some five or six inches in diameter.

Quite a different type of dental armature is presented by the millstones of the beaked rays (*Rhinobatidae*). Here the teeth take the form of closely packed diamond-shaped knobs, arranged in an alternating manner, so that although they present longitudinal rows, yet they also show oblique series, so as to give rise to a quincunxial pattern. Then, again, the entire millstone in each jaw is thrown into a series of undulations, so that the upper one exhibits a large median boss, flanked by a pair of smaller undulations, which are received into corresponding

depressions in the lower millstone. It is difficult to conceive a machine better adapted for crushing than is presented by the jaws of the beaked rays.

Of a much less powerful type are the millstones of the ordinary rays or skates (*Raiidae*) of our own coasts; and among these the common thornback (*Raia clavata*) presents a very remarkable condition, since the individual teeth take the form of obtuse knobs in the female, whereas in the male the centre of each of these knobs acquires a sharp recurved point. Since everything in nature has a meaning, it would seem a fair inference that there must be some important difference between the food of the male and female thornback, but I have not come across any observations bearing upon the subject.

Among the fossils to be obtained occasionally from the workmen in large chalk-pits are teeth in the form of convex quadrangular bosses, the marginal portion of which consists of a broad granular area, while the centre is occupied by a variable number of bold ridges, or folds, between which are often irregular knobs. It is from these ridges that the fish takes the name of *Ptychodus*. For a long time it was uncertain how these teeth were arranged, but careful comparison of a number of more or less incomplete series *in situ* has at length solved the problem. In the lower jaw the complete millstone was formed by a median row of large teeth, on each side of which were six or seven other rows composed of teeth gradually decreasing in size from the centre to the margin. In the upper jaw, on the other hand, there was a central row of small teeth, flanked on each side by a row of large ones, externally to which came a series of rows gradually diminishing in size. From this mode of arrangement it is inferred that *Ptychodus* was a ray; and the whole dental structure is as remarkable

for its perfection as a crushing machine as it is for its intrinsic beauty.

Even more elegant from an aesthetic point of view are the "millstones" of the Port Jackson shark (*Cestracion*) and its allies. In place of forming a continuous plate across the palate after the fashion of the eagle-rays, the individual teeth in this group are arranged in oblique bands round the edges and inner sides of the jaws,* showing in the hinder region a melon-shaped swelling of remarkable gracefulness, which would form an attractive ornament for the capital of a pillar. In this melon-like portion of the millstone the individual teeth form bluntly convex oblongs; those of one row being remarkably larger than all the rest, while the rows in front and behind this do not correspond with one another in size. Examined with a lens, each of these blunt teeth is seen to have a minutely pitted structure, while its median longitudinal line is marked by a narrow smooth streak. New teeth are being continuously produced on the margin of the series on the inner side of the jaw; and as the outer ones become worn away, the whole series is pushed over towards the edge of the jaw. Proceeding from the larger rows of teeth towards the front of the jaw, it will be seen that as the individual teeth become gradually shorter their smooth median line gains prominence, till it finally develops into the sharply pointed cusp surmounting each of the front teeth.

As already said, the Port Jackson shark and a few other nearly related species (all of which, by the way, feed on shell-fish and crustaceans) are the only sharks with millstones met with in our present seas. And it is fortunate that these have lived on, as otherwise we should never

* Strictly speaking, the tooth-bearing cartilages of sharks are not true jaws.

have gained a true idea of the dental armature of their extinct relatives which abounded in the seas of the Jurassic epoch. Visitors to Whitby must be familiar with certain black oblong fossils of about an inch and a half in length known to the quarrymen as "fossil leeches." These are the hinder teeth of an extinct shark (*Asteracanthus*) nearly allied to the Port Jackson species, but of much larger size; and although they are more rugose than pitted, they show the same smooth line on the summit. A beautiful specimen from Caen, in the British Museum, shows that the arrangement of these hinder teeth was almost exactly the same as in *Cestracion*, which may thus be regarded as a survivor from a long-past epoch of the earth's history.

But there were other "millstone-mouthed" sharks at a still earlier period which appear to have been allied to *Cestracion*, although the degree of relationship is uncertain. In these Palaeozoic sharks, as exemplified by *Cochliodus*, the series of hinder teeth seems to have had an arrangement very similar to that obtaining in *Cestracion*, but the individual teeth of several series were more or less completely fused into a single solid plate, the ridges on which mark the original lines of division between the component series. These sharks exhibit, therefore, one among many instances where the earlier forms of a group are in some respects more specialised than their descendants.

So much space has been taken up by the rays and sharks that only a few lines remain for the millstones of the enamel-scaled fishes. In none of these do the teeth, which are developed on most of the bones of both the upper and lower jaws, ever form continuous plates; and they are generally either spherical or kidney-bean-shaped and arranged in more or less longitudinal rows. Unlike those of the sharks and rays, these teeth, as in the familiar *Lepidotus* of the Wealden,

are replaced by vertical successors; and their mode of development is so peculiar that in some cases the new tooth is placed wrong way up beneath the one it is destined to replace. In other instances, as in *Coelodus* from the Folkestone Gault, successional teeth have not been observed, and the mode of renewal is consequently still unknown. Although within the limits of a single article it is impossible to do more than give the crudest sketch of a vast subject, yet what has been written may be sufficient to attract my readers' interest to an extremely fascinating branch of zoological study.

PART II

AN INVISIBLE MONKEY

In most English dictionaries the verb "to mimic" has for its synonyms "to ape, imitate, counterfeit, or mock"; and it is thus intimately connected with the monkey tribe, whose imitations of human gestures and actions form one of their most prominent characteristic features. Till a few years ago naturalists were, however, totally unacquainted with any instance among these animals of "mimicry" in its scientific sense—that is to say, no case was known where a monkey, for the sake of protection, resembled in form or coloration either some other animal or an inanimate object. During a journey to Mount Kenya and Lake Barengo, in East Africa, Dr. J. W. Gregory, late of the Natural History Museum, discovered that the peculiar type of coloration characterising certain African monkeys is protective in its nature, and that these monkeys, when in their native haunts, are thereby rendered practically invisible.

The monkeys in question (one of which is represented in the annexed plate) are known to the natives of certain districts of East Africa by the name of "guereza." They belong to the group of thumbless apes (*Colobus*), which are restricted to the African continent, where they take the place of the langurs, or sacred apes, of India and other Oriental countries. From the other thumbless apes the guerezas (or those species to which that name properly

applies) are distinguished by their long silky black and white coats, which are much sought after by the natives of Africa as articles of costume and for purposes of decoration. In the typical Abyssinian guereza, the greater part of the fur of the body and limbs is of a deep shining black, but from the shoulders there depends a mantle of long white silky hairs extending down each side and meeting on the lower part of the back, so as to hang down over the sides of the body as well as over the hips and thighs. The terminal third of the tail is also clothed with long white hairs. Strikingly handsome as is this species, it is excelled in this respect by the East African guereza, in which the base of the tail is alone black, the whole of the remainder of that appendage being developed into a magnificent white brush, which may be compared to an Indian *chowri*, or fly-whisk.

Black and white is a type of coloration so conspicuous, and, at the same time, so rare among the larger mammals, that whenever it occurs we may be quite sure it is developed for some special purpose, although, unless we have an opportunity of seeing the animals in their native haunts, it is almost impossible to divine what that purpose may be. It is met with elsewhere in the zebras, and also in the great panda (*Aeluropus*) of Tibet. Although the former animals are conspicuous enough in a stall at the "Zoo," or when stuffed in a museum, travellers tell us that when seen in the haze of an African desert their black and white stripes fade at a very short distance to an almost invisible grey. This may even be observed in a hot summer, when the grass is burnt brown, in the Duke of Bedford's seat at Woburn Abbey, where several of these beautiful animals roam at will in the park during the summer months.

WHITE-TAILED GUEREZA.

From a mounted specimen in the British Museum. [*To face p.* 168

With regard to the great panda, we have at present no information. It may be suggested, however, that the startling contrast presented by its streaks and patches of creamy white on a jet-black ground may harmonise with patches of snow on black rocks, or possibly with the lines of light between the dark stems of forest trees.

Be this as it may, Dr. Gregory's observations have solved the problem of the use of the remarkable coloration of the guerezas, which has so long puzzled naturalists. Like others of their kind, these monkeys pass most of their time high up on trees, where they sleep either resting on a bough or hanging beneath by their hands, or hands and feet. Now, in the dense forests clothing Mount Kilima Njaro and other districts of East Africa, the black-barked boughs are thickly draped with pendent masses and wreaths of grey beard-moss or lichen, which reach for several feet below them. "As the monkeys hang from the branches," writes Dr. Gregory, "they so closely resemble the lichen that I found it impossible to recognise them when but a short distance away."

We have thus decisive evidence that the black and white coloration of the guerezas protects these animals by a close resemblance to their inanimate surroundings. There are, however, certain smaller mammals with a similar type of coloration in which the startling contrast of black and white seems to be for the purpose of rendering them conspicuous; and as some at least of these creatures are endowed with a most disgusting odour, their conspicuousness has been regarded as warning other animals from attacking them. The best known of these creatures are the ill-famed American skunks, which are in the habit of stalking over the Argentine Pampas in full daylight, with the most consummate indifference to the presence of

other and more powerful animals. And any one who is in doubt as to the cause of this proud indifference should read Mr. W. H. Hudson's account of the terrible and lasting effects of their foetid excretion, as detailed in "The Naturalist in La Plata." Less familiar is the so-called Cape polecat (*Ictonyx*), an animal of about the same size as an ordinary polecat, but having its fur marked with broad longitudinal bands of blackish brown alternating with white. As this creature is stated to have an odour as disgusting as that of a skunk, there can be little hesitation in classing it among animals possessing "warning odours."

Another member of the same family (*Poecilogale albinucha*) from South Africa is likewise conspicuously banded with blackish brown and white, and thus closely resembles the Cape polecat, for which it might readily be mistaken. Unfortunately, its habits seem very imperfectly known, and it is difficult to ascertain whether it has an odour as powerful as that of its larger cousin. It is very probable however, it has not, and that its coloration is a true mimicry of that of the latter. If this be so, we shall have the pied coloration of the animals above mentioned attributable to three distinct causes. In the case of the guereza it affords protection, from its resemblance to inanimate surroundings; in the skunk and Cape polecat it serves to warn other animals from attacking a noisome beast, which is thereby protected; while the South African weasel enjoys immunity from attack from being mistaken for the similarly coloured polecat.

SOME QUEER-NOSED MONKEYS

Of all the features of the human countenance none seems more prone to exhibit marked variations in size and shape than the nose. A broad and flattened nose, is, for instance, characteristic of negroes and Australian natives, whereas the classic or Grecian nose is found only among the highest types of the Caucasian races of Europe. But while the nasal organs of the lower races of mankind differ in general from those of the higher peoples of Western Europe, yet it is among the latter that perhaps the greatest amount of variation in this respect may be noticed. And although even among these mixed Western nations a considerable amount of such nasal variability is evidently hereditary and distinctive of particular families or races, yet there are many instances in which it appears largely individual, although it may, of course, be due to reversion. Be this as it may, it will suffice for our present purpose to note that among European races a distinctly "snub-nosed," or "tip-tilted," type is not uncommon on the one extreme, while at the other we have what is commonly called the "long-nosed" type; the latter being broadly distinguished from the arched Roman, or aquiline, nose.

Now, it is a remarkable fact in natural history that whereas the great majority of the monkeys and apes of the Old World have noses of an ordinary pattern—that is to say, not very far removed from the type characterising

the inferior representatives of the human race—three of them have developed peculiarities in this respect which entitle them to be regarded as among the most extraordinary of all four-footed beasts. And not the least remarkable circumstance in connection with these nasal eccentricities is that the two extremes are found in members of a single group inhabiting widely distant and completely isolated areas.

Before referring to the species displaying these remarkable peculiarities, it will be well to briefly refer to their nearest relatives. These are most familiarly known by the sacred Hanuman monkey, or langur, of India, which is one of a large group of species inhabiting most of the Oriental countries; one kind, the Himalayan langur, being found at a considerable elevation in the outer hills of the mighty range from which it takes its name. And in winter, or early spring, these large grey monkeys may frequently be seen disporting themselves among pines heavily laden with snow. As distinctive features of the langurs, reference may be made to their slim build, long hind-legs and tail, and the absence of pouches in the cheeks for the storage of food. Their hair is long and coarse, and may be of any colour from slaty grey to bright foxy red or black. All have, for monkeys, fairly well-formed noses, of ordinary dimensions. Unlike the majority of the members of their order, they feed on leaves in preference to fruits; and, as showing how similarity of habit gives rise to similarity of structure (or, if the reader so please, *vice versa*), it is interesting to note that the langurs have complex stomachs, strikingly similar to those of sheep and ruminants in general; most other monkeys having simple stomachs of the normal type.

As already mentioned, the three species of monkeys

MALE PROBOSCIS-MONKEY.

A species confined to Borneo.

[*To face p.* 172

which have gone in for eccentric nasal development are near relatives of the langurs. The first of these, which has been known in Europe since 1781, is an inhabitant of Borneo, where, be it observed, there are also true langurs with normal noses. As may be seen from the figure, which represents a male in the Natural History branch of the British Museum, the proboscis monkey, as the species is called, is characterised by the inordinate length of the nasal organ of the adult male, which projects far in front of the line of the mouth, and gives to the whole physiognomy a most grotesque appearance. So remarkable, indeed, is the face of this monkey, that the first view of a stuffed specimen suggests to the beholder that it has been "faked," after the fashion of the "bogus" animals formerly manufactured by our Japanese friends. The nostrils are situated on the under surface of the tip of this ungainly proboscis, and are separated from another by an extremely narrow partition. According to recent observations, the nose, instead of projecting straight forward, should bend down in front of the mouth. In the case of the female the degree of nasal development is considerably less; and in the young of both sexes the nose is comparatively short, with the nostrils visible from the front, instead of being directed downwards. In point of size, the proboscis monkey is a comparatively large animal, the length of the head and body of the adult male being about thirty inches, and that of the tail some three inches less. Its colour is likewise conspicuous and striking, the upper parts, with the exception of a light band across the loins, being brilliant chestnut, and the face, which is fringed with long yellowish hair, a reddish flesh-colour.

Far more brilliant in colour is the first of the two Tibetan species which exhibit the opposite type of nasal

eccentricity in the langur group. But these snub-nosed monkeys, as they may be appropriately called, are fully as large as the Bornean species, and as they are of much stouter build, both as regards body and limbs, they look considerably bigger. Instead of a proboscis-like development of nose these two very peculiar monkeys have their nasal organs bent suddenly upwards at a sharp angle to the line of the face, so that the nostrils are fully visible from the front; the whole aspect of the face being curiously piquant. The species here figured—the orange snub-nosed monkey—was first made known to European science by the French missionary, Abbé David, who obtained specimens while travelling in the province of Moupin, in Eastern Tibet. Some of his specimens are preserved in the Zoological Museum at Paris; and the coloured plate of a female has long been the only figure available to naturalists. Thanks, however, to an energetic English naturalist resident in China, the British Museum a few years ago acquired a pair of these monkeys; the figure being taken from the male, which has been mounted for exhibition, and forms one of the most attractive specimens in the large monkey case. Since the photograph does not attempt chromatic effect, it is necessary to mention that the general colour of the upper-parts is rich olive-brown, flecked with yellow and suffused with rufous, while the sides of the face, the lower part of the forehead, and the under-parts are brilliant yellowish orange, tending to full orange on the face, the naked portions of which are pale blue. Across the loins there is a light patch comparable to that of the proboscis monkey; the tail being proportionately rather shorter than in the latter, with a distinct tendency towards a club-shape. Altogether, the appearance of the animal is highly peculiar, both from the point of view of form and of coloration.

ORANGE SNUB-NOSED MONKEY.

A native of Sze-Chuen.

[*To face p.* 174

The head, for example, in addition to its "tip-tilted" nose, is noticeable for its extreme massiveness, which gives an almost leonine appearance. And this general massiveness is equally observable in the limbs, which are relatively shorter than in the true langurs; the feet being especially heavy and broad, with their toes almost concealed by long hair.

And here the attention of the reader may be directed to the circumstance that animals inhabiting cold countries (and Sze-chuan, where the British Museum specimens were obtained, can be very cold) are almost always much more heavily and substantially built than their relatives from warmer climes. An excellent instance of this phenomenon is afforded by the case of tigers in the same collection; the Bengal tiger being a long lanky beast, while its cousin from Mongolia is a heavily built creature, with extraordinarily massive limbs. Of course the longer hair of the Central Asiatic animal tends to exaggerate its general massiveness, which, however, would be perfectly apparent even without this extraneous aid. Possibly a stout and heavy build, especially as regards the limbs, may aid in protecting the circulatory system from the effects of extreme cold.

As regards the habits of the orange snub-nosed monkey, our information is of the most meagre description. These animals are stated, however, to congregate in troops of considerable size, and to ascend the tallest trees (the part of Tibet they inhabit being more or less wooded) in search of fruits, which they much prefer to leaves. When pressed by hunger, leaves and the tender shoots of bamboo are said to form their staple nutriment. Bearing in mind this alleged partiality for fruits, it would be interesting to determine whether the stomach of these monkeys is as complex as that of the true langurs.

In 1899 the professors of the Paris Museum were enabled to publish, with excellent coloured plates, the description of a second species of the same group, also coming from Tibet and the adjacent districts of North-Western China.

This second species, which may be popularly known as the slaty snub-nosed monkey, is fully as large as its more brilliantly coloured relative, which it also resembles in the form of its nose. The tail is, however, much more bushy, and long-haired throughout. And while the colour of the upper-parts and outer and front surfaces of the limbs is dark slaty brown, the cheeks, under-parts, and thighs are mostly pure white; the naked portions of the face being flesh-coloured.

The specimens of the slate-coloured species in the Paris Museum were obtained in the north-west extremity of Yun-nan, on the left bank of the River Mekong, in the neighbourhood of Yerkalo, and it seems evident that the species inhabits the crest of the long range separating the valley of the Mekong from that of the Yang-tsi-kiang. During the summer it is probable they frequent that side of the range which overlooks China, while their winter quarters would appear to be the side directed towards Tibet. The native name of "tchru-tchra," or snow-monkey, sufficiently indicates the severity of the climate of the region they inhabit. Probably the Blue River forms the line of division between the distributional areas of the slaty and the orange species, the latter being found in Southern Kansu, Northern Sze-chuan, and Moupin.

Despite their long isolation from the sphere of European science, one, if not both, of these peculiar monkeys seems to have been known to the Chinese from time immemorial, for in a work entitled "Shan-Hoi-King," or "Mountain and Sea Record," which has been supposed to date from earlier

than 2000 B.C., a so-called man of the Heu Yeung kingdom appears, from his tip-tilted nose, to be one or other of the species under consideration.

In the foregoing remarks we have treated the three species of monkeys with eccentric nasal development merely as zoological curiosities. But it will be evident to every thinking mind that there must be a reason for such strange departures from the normal, and until we discover such reason we cannot be said to know anything worth knowing about these animals. Unfortunately, those who have had the opportunity of seeing these monkeys in their native haunts have not assisted us in this matter, and there is an absolute lack of information in regard to this all-important point. That the problem cannot be solved by guessing on the part of the stay-at-home naturalist may be regarded as practically certain. At the present day, owing partly to the anxiety to describe new species and varieties, and partly to the desire to obtain specimens of every animal for our museums, there appears a great tendency for intelligent explorers and travellers to degenerate from field-naturalists into mere collectors. And the pity of this is too obvious to need more than mention. It is indeed often said that it is most important to obtain specimens of species before they become extinct; but the discovery of the *raison d'être* of the tip-tilted nose of the Tibetan monkeys, or of the proboscis-like organ of their Bornean cousin, would be a thousand times more valuable than the acquisition of untold specimens of either. And even the recently acquired knowledge of the existence of the second species of snub-nosed monkey pales into unimportance when contrasted with the unsolved problem. By all means, then, let all those who have the opportunity put mere collecting into a very subsidiary place, and devote

all their energies to the solution of problems of this nature (and their name is legion) before it becomes for ever too late.

After what has been said as to the necessity of actual observation to determine the reason for the peculiar nasal development of these monkeys, it would obviously be out of place to attempt to solve the problem in any other way. Attention may, however, be directed to the circumstance that the chiru, or Tibetan antelope, has a remarkably swollen and puffy nose. And although the saiga antelope, of the plains of Central Russia, has an equally remarkable nasal development, yet it seems highly probable that in the case of the chiru, at any rate, the enlarged size of the nasal chamber and nostrils is correlated with the rarefied atmosphere of the elevated plateau on which that ruminant dwells. The snub-nosed monkeys, although living at a considerably lower elevation than the chiru, are yet "well up in the world"; and since the shape of the nose in the former would appear designed to admit the passage of as much air as possible with the least impediment, it may perhaps be suggested that the habitat has something to do with the nose structure. As to the reason for the genesis of the ungainly proboscis of the Bornean monkey, I have not even the rudiment of a theory to offer my readers.

A REMARKABLE MAMMAL

My readers are not to imagine that the animal whose portrait appears as a frontispiece to this work is one new to science, or even one whose structure has hitherto been imperfectly known. On the contrary, it has been known to science for nearly a century and a quarter; but it is altogether such a peculiar and interesting creature that it may well form the text of an article.

Like so many of its cousins the lemurs, the aye-aye is an inhabitant of Madagascar, from the west coast of which island the first specimen known to European science was brought to Paris in 1780 by the French traveller Sonnerat, who discovered several other curious mammals and birds. By the naturalists of that time, despite the remarkable peculiarity in the structure of the forepaws mentioned later on in this article, it was regarded as a squirrel, and accordingly named *Sciurus madagascariensis*. It was, however, soon after apparent that, whatever might be its real affinities, it could not rightly be retained in the same genus as the true squirrels; and it was accordingly renamed, at first *Daubentonia*, and subsequently *Chiromys* (*Cheiromys*). The justification for the proposal of this second title was that the first had been previously employed in botany, which was then (although not now) regarded as a bar to its use in zoology. And at the present day some

naturalists think that the almost forgotten *Daubentonia* ought to be resuscitated, and the familiar *Chiromys* abolished. This, however, is a matter which may be left for the specialists to settle among themselves.

But it is not with regard to its scientific name alone that the creature has been unfortunate; a difference of opinion having arisen as to its right to the name "aye-aye," by which it has been universally known since Sonnerat's time. That traveller, it appears, had at first two living specimens captured on the west coast of Madagascar; and when these were seen by the natives of the east coast (where the species is unknown), they ejaculated "aye-aye"—or more probably "hai-hai"—which seems, not unnaturally, to have been regarded as the native name of the animal. At least as early as 1860 it was, however, suggested that in place of being the animal's name, it was merely an exclamation of surprise at the sight of a strange and unknown creature. And this view of the case is maintained to be correct by Mr. Shaw, a missionary who resided for many years in Madagascar. On the other hand, another missionary, Mr. Baron, affirms that the name "hai-hai" is derived from the creature's peculiar cry.

When those who have the best opportunities for deciding arrive at such opposite conclusions, it is difficult for others to form a judgment. I have, however, consulted a naturalist familiar with Madagascar, who tells me that "hai" is undoubtedly the Malagasy expression of surprise or wonderment; and that as the aye-aye is a shy and rare creature, seldom seen even by the natives of the districts where it is found, and then regarded with superstitious awe, the colloquial expression of wonderment may well have become its accepted name.

If, however, "hai-hai" be, as Mr. Baron asserts, the creature's own cry, then it would seem more likely that the exclamation has been derived from the animal, and not that the animal has taken its name from the exclamation. Anyway, there seems undoubtedly to be some kind of connection between the exclamation "hai-hai" and the name "aye-aye," and we may therefore be content to accept the latter as the popular title for *Chiromys madagascariensis*. The naturalist to whom allusion is made above tells me, however, that the creature certainly has another vernacular title in some parts of the island.

As already mentioned, the naturalist Gmelin, by whom the aye-aye was originally described, regarded it as a kind of squirrel—an opinion shared at first by the great anatomist Cuvier. This view of its relationship was doubtless formed from the somewhat squirrel-like appearance of the animal, and the approximation made by its teeth to the rodent type. When, however, the Paris specimen was more carefully examined, and its skull and certain other bones removed from the skin, it became apparent that its relationships were evidently with the lemurs; the German naturalist Schreber being the one to whom the honour of this identification is due.

From Schreber's time till 1860 little or nothing more was done to advance our knowledge of the aye-aye, of which the Paris specimen remained the only example in Europe. In 1858, however, Dr. Sandwith left England for Madagascar, and previous to his departure Sir Richard (then Professor) Owen impressed upon him the importance of endeavouring to obtain specimens of this rare animal. A year later the Professor received a letter stating that with much difficulty a specimen had been secured; and this in due course arrived in England preserved in spirit.

It was dissected and described by Owen in 1860; and from the beautiful drawing by Wolf which accompanies that memoir the figure illustrating the present article is reproduced.

Soon after the arrival of the specimen sent to Owen a living example of this strange animal was received at the menagerie of the Zoological Society in Regent's Park; this being a female presented in 1862 by Mr. E. Mellish. An excellent account of the habits of this animal in captivity was published by the late Mr. A. D. Bartlett in the Society's *Proceedings* for the same year. A male and female were also received in the menagerie in the summer of 1883, while a fourth specimen was purchased in the autumn of 1887.

The ordinary public saw, however, little or nothing of these specimens, for as might be inferred by its large eyes, the aye-aye is essentially a nocturnal creature. remaining comfortably curled up during the daylight hours, and only venturing out as darkness comes on. In this respect it resembles the majority of its cousins the lemurs; and were we naming animals afresh, the name lemur would in some ways have been more appropriate to this particular species than to those to which it properly belongs. For the word "lemur" in its original signification means a ghost, and not only is the aye-aye stealthy and ghost-like in its movements, but it is regarded with superstitious dread by the Malagasy, who believe it to be a kind of spirit.

As already mentioned, the aye-aye has somewhat the appearance of a large dark-coloured squirrel; and in size it may be compared roughly to a cat, the total length being about three feet. The head and face are short and rounded; and the large eyes are furnished with a membrane

which can be drawn across them from one side. The large and rounded ears, which are inclined backwards, are naked and dotted with a number of small tubercles. The blackish brown hair all over the body is long and coarse, but becomes longer still on the long and bushy tail. Nothing very remarkable exists in the structure of the hind-limbs, which somewhat exceed the front pair in length; but the forepaws, or hands, which are unusually elongated, display a most strange peculiarity. As in lemurs generally, the thumb is capable of being opposed to the index finger, which is short; the latter, together with the fourth and fifth digits, being of normal thickness and provided with long compressed and pointed claws. The third or middle finger, as is beautifully shown in the figure, is, however, quite unlike the others, being extremely thin and spider-like. Of its use, mention will be made later.

This attenuated middle finger is one of two marked peculiarities whereby the aye-aye differs so strangely from its relatives the lemurs. Its other peculiarity is to be found in its dentition. Ordinary lemurs, it may be observed, have from thirty-two to thirty-six teeth; the incisor or front teeth, although presenting certain peculiarities of form, agreeing numerically with those of monkeys and man in most cases. In the aye-aye, however, there are only eighteen teeth, all told; the incisors being reduced to a single pair in each jaw, the canines, or tusks, wanting, and the cheek-teeth, or grinders, comprising four pairs in the upper and three in the lower jaw. Nor is this all, for the incisors, which grow throughout life, are large somewhat chisel-like teeth, recalling in many respects those of a beaver or other rodent, although with peculiarities of their own which render them easily distinguishable from those of all

the members of that group. Still, the whole character of the dentition is so essentially rodent-like that there is little wonder the old naturalists regarded the aye-aye as a near relative of the squirrels.

The general anatomy of the aye-aye, especially the structure of its skull, shows, however, that it is certainly a near relative of the lemurs, which are themselves distant cousins of the monkeys, from which, among many other peculiarities, they differ by their expressionless, fox-like faces. The aye-aye is therefore classed as a lemuroid; of which group, owing to the peculiarity of its dentition and its attenuated middle finger, it must be regarded as a highly aberrant and specialised member.

Unfortunately, in spite of recent explorations in the superficial deposits of Madagascar, where bones of huge extinct lemuroids have been disinterred, nothing whatever is known as to the ancestry of the aye-aye. Evidently, however, it must be a comparatively ancient type, for, if we may judge from the analogy of other groups, a long period of time must have been required to allow of the gradual evolution and development of its characteristic peculiarities of dental and manual structure.

Evidently these peculiarities must be connected with its mode of life. And we learn from those who have observed the creature in its native forests or in captivity, that the aye-aye, unlike the true lemurs, subsists largely upon wood-boring insect larvae, especially on the larva of a beetle known to the Malagasy by the name of andraitra. Apparently the aye-aye possesses a sense of hearing so acute that when on a bough it can hear the faint rasping sound made by the jaws of the andraita as it bores its way through the wood in the interior. Thereupon it at once sets to work with its powerful front teeth to chisel away the intervening

wood till it opens up the tunnel of the burrowing larva. As soon as the tunnel is reached the attenuated middle finger is thrust in, either to act as a probe to determine the position of the larva, or to drag it out from its hiding-place, or perhaps for both purposes. Some uncertainty still obtains as to the exact details of these and other operations of a like nature, for our information on these points appears to be mainly, if not exclusively, based on native accounts. There is, however, little doubt that the *modus operandi* is in the main as described above.

We thus have a sufficient and satisfactory explanation of the reason why the aye-aye differs so remarkably in its dentition and in the structure of its hand from all its living kindred. If, however, we attempt to account for the gradual development of these peculiarities by what is commonly called natural selection, we encounter considerable difficulty. It is easy to conceive how the ancestors of the horse lost their lateral toes by disuse, but how an ancestral aye-aye gradually reduced the size of its middle finger till it assumed the attenuated proportions of its existing representative is very hard to understand, seeing that a slight diminution in the calibre of this digit would be of little or no advantage. Some much more potent cause than "natural selection" seems necessary in this, as in many other instances.

As regards its general mode of life, the aye-aye wanders through the silent forest at night in pairs, and never appears to associate with others of its fellows than its partner. Probably the partnership is for life, but on this point we have no definite information. The aye-aye is one of the comparatively few mammals which build a regular nest; this being constructed, according to Mr. Baron, of the carefully rolled up leaves of one particular kind of tree, and lined with small twigs and dry leaves; the whole structure having

a diameter of about a couple of feet. Apparently the sole use of this nest is as a nursery, and in it at the proper season the female brings forth a solitary offspring—whether born naked or clothed with hair does not seem to be ascertained. The female alone builds the nest, which is placed securely in the fork of a tree.

In addition to the use described above, the attenuated middle finger is employed to comb the hair and clean the eyes, mouth, and nose; the animal, when thus engaged, generally suspending itself head-downwards from a bough by its hind-feet; at any rate, this is the case in captivity. As a rule, the food is not held in the paws, after the usual monkey and lemur fashion, although the act of drinking is performed in an ape-like manner, the fingers being first dipped in water and then sucked.

Besides the boring larvae already alluded to, it is certain that the aye-aye will eat various other kinds of food, although native accounts differ to a considerable extent on this point. Some say, for instance, that it subsists largely on birds and their eggs, while others assert that honey is its favourite food. Probably there is some degree of truth in all these accounts, and that the creature is to a certain extent omnivorous. It will eat sugar-cane with considerable gusto, and in captivity has been known to take bananas. But that these latter are not its natural food would seem to be evident from the fact that they stick in and clog its teeth.

As regards its distribution, the aye-aye is a very local animal; its chief habitat being the great forest clothing the eastern border of the great central plateau of the island. Here, however, it is apparently restricted to the district forming the confines of the provinces of Sihanaka and Betsimisaraka, which is situate about five-and-twenty miles inland in latitude 17° 22′ S. I am, however, informed by

the friend mentioned above that an aye-aye occurs in the south of the island, which, if its habitat is isolated from that of the typical form, may turn out to be a new local race, or possibly even a distinct species.

Although the aye-aye is certainly far from being a common animal, yet it is probably less rare than is often supposed. Its supposed great rarity appears to be largely due to the dread in which it is held by the natives, who can seldom be induced to capture a specimen. It is believed to be endowed with the power of causing the death of those who attempt its capture, and it is consequently only some of the bolder natives who will venture on this undertaking, and then only after providing themselves with a charm to counteract the effects of the creature's supposed supernatural power. Occasionally, according to Mr. Baron's notes, it is taken in traps set for lemurs; but it is then, unless the owner is possessed of the aforesaid charm, invariably set at liberty, after being anointed with fat in order to propitiate its goodwill and forgiveness. Only very occasionally is a specimen offered for sale in the market at Tamatave, when a good price—presumably from Europeans—is always obtained.

THE PEDIGREE OF THE CAT *

ALTHOUGH it is a common notion that our ordinary "tabby" is the direct descendant of the European wild cat (*Felis catus*), now nearly exterminated in Britain, the best modern authorities are of opinion that the real ancestor is a wild species inhabiting North-Eastern Africa, and commonly known as the Egyptian cat (*Felis libyca*); a reputed variety of the same species being stated to inhabit parts of Southern Europe. The facility with which several of the smaller species of wild cats will breed together, and likewise the circumstance that the domesticated cats of Asia apparently have an origin distinct from that of the European breeds, renders the subject one of more difficulty than might at first seem to be the case.

With regard to the differences between the domesticated and the wild cat, it has been generally asserted that the latter is considerably the larger animal of the two, although the comparisons made by Dr. E. Hamilton, who has published a book on the subject, indicate that this is not really the case. The statement that the tail of the wild species is shorter and stouter seems largely due to the circumstance that the fur is more abundant and bushy,

* A portion of the substance of this and the next article appear in the one on "the Origin of Domesticated Animals." In spite, however, of a certain amount of repetition, it has been thought advisable to let all three stand in their original form.

so that the tail of the domesticated breeds appears longer and more slender; but, on the whole, it seems that in domesticated cats the tail does differ to a certain extent in this respect from that of the pure-bred wild animal, although individuals of the domesticated breeds are sometimes met with which exhibit scarcely any difference in this respect from the wild cat. Obviously, then, the tail—on which so much stress has been laid—is not a matter of very much importance in the inquiry. With regard to the general coloration of the fur, although both the wild cat and a large number of individuals of the old European domesticated breed are what is commonly known as the "tabby" type, the markings of pure-bred specimens of the former are stated to present certain differences from those of the latter, and are described as being more tiger-like. Then, too, the dark rings on the tail of the wild cat appear blackish brown when held against the light, whereas those of the domestic tabby are jetty black.

Perhaps the most important point in which domesticated cats differ from the pure-bred wild cat, and thereby resemble the Egyptian cat, is in the coloration of the hind-foot. Dr. A. Nehring, of Berlin, who first brought the fact to notice, states that in the Egyptian animal the pads on the under-surface of the toes are black, this colour extending upwards on the foot as far as the heel-bone, the under-surface of this part of the limb being in some cases wholly black, but in others marked with black stripes on a lighter ground. On the other hand, the pure-bred wild cat has only a small black spot on the pads, while the colour of the fur on the under-surface of the foot as far up as the heel-bone is some shade of yellow or yellowish grey. Since all European domesticated cats—except, of course, those which are wholly black or white—agree with

domestic cat from the Egyptians by means of the Phoenician traders, as in the very earliest and rudest Etruscan tombs in the neighbourhood of Civeta Castellani (the contents of which are now in the Museum of Papa Giulio, near Rome) there are unmistakable traces of the Phoenician trade." Without denying that such may have been the case, the discovery of the Mediterranean cat, as already mentioned, suggests the possibility of a European origin for the domesticated breed. On the other hand, the Mediterranean cat itself may prove to be merely a feral race derived from an Egyptian importation.

Be this as it may—and the problem is one hardly capable of decisive solution—Dr. Nehring is of opinion that wild cats were originally brought under subjugation by stationary agricultural tribes, to whom it must have been of the utmost importance that their hoards of grain should be protected as much as possible from the ravages of rats and mice.

When once a domesticated breed had become established in Europe, it would certainly have freely crossed with the wild cat. And it seems highly probable that to such crossing is due the great prevalence of "tabbies" in Europe previous to the introduction of the now fashionable Persian breed, the wild cat having the dark stripes broader, and frequently more numerous, than they are in the Egyptian cat.

As to the date of introduction of the domesticated cat into Britain, the earliest written evidence of its existence there occurs in the laws of the Welsh prince Howel Dhu, which were enacted about the middle of the tenth century. Certain remains of cats have, however, been discovered in Roman villas in this country, which appear to belong to the domesticated breed; and if these be rightly

identified, the first introduction of the animal must have been at a much earlier date, the Roman evacuation having taken place about the middle of the fifth century of our era.

Although cats of all colours are now met with, and some of them at least have been long known there, the prevalence of "tabby" is, as already said, very characteristic of the old domesticated breed in Europe. In Eastern Asia, on the other hand, as was long since pointed out by that very observant naturalist the late Edward Blyth, "tabbies" are unknown, and either spotted or uniformly coloured cats are prevalent. In India, for instance, where they have not been crossed with a European stock, the ordinary cats are either spotted or fulvous, with barred limbs. In Siam we have the peculiar and valuable Siamese cat, characterised by the uniformly tawny fur of the body, the dark muzzle, under-parts, and limbs, the short legs, and blue eyes. Again, the long-haired Persian or Angora breed is also uniformly coloured, the prevalent tints being white, yellowish, or greyish.

Among the smaller wild species of the genus indigenous to India is the desert-cat (*Felis ornata*), of which the general colour is pale sandy, with small roundish black spots on the body and elongated spots or streaks on the neck and face, two dark bars being present on the inner side of the fore-limb. From this species have probably originated the spotted domesticated cats of India, in which the spots tend to aggregate into streaks on the fore-part of the body, while the slender tail is ringed. Probably, however, considerable crossing has taken place with two other wild Indian species—namely, the leopard-cat (*F. bengalensis*) and the tiny rusty-spotted cat (*F. rubiginosa*). Many of these spotted Indian domesticated cats have run

wild, and one such has been described as a distinct species.

With regard to the fulvous domesticated Indian breed, in which the fur of the body is uniform tawny, the legs barred, and the tail ringed, it seems probable that this too was originally descended from the desert-cat, but that it has derived its uniform coloration from the jungle-cat (*F. chaus*), which, as already said, is related to the lynxes. That it is not the direct descendant of that species seems evident from the different relative lengths of its tail and limbs, and the absence of pencils of hair on the ears.

I have already said that in the opinion of Prof. Martorelli the jungle-cat and steppe-cat are descendants of the Egyptian cat; and as the desert-cat and steppe-cat are closely allied, it follows that, if his views be correct, all the Indian domesticated cats trace their ultimate origin to the Egyptian cat.

Nothing definite is known as to the origin of the beautiful Siamese cat, but it seems possible that it may be the descendant of the golden or bay cat (*F. temmincki*) of the Malay countries, which is a uniformly coloured bright ferruginous-red or dark-brown species, with a relatively short tail.

There is likewise no certain information with regard to the pedigree of the Persian or Angora cat. The deserts of Central Asia are, however, the home of a very peculiar species of the genus *Felis*, which was first described by the Russian naturalist Pallas, under the name of *F. manul*, and is popularly known as Pallas's cat. This species, which is about the size of an average domesticated cat, differs from all other wild Old World members of the genus by the great length and softness of its fur. Its general colour is pale whitish grey, with some narrow dark markings on the

chest, loins, and limbs, the tail being short and ringed. With the exception of the shortness of the tail and its dark rings, all the characters of this species are just those which might be expected in the ancestor of the Persian breed, and it is quite probable that the points mentioned may have been eliminated by careful selection or crossing.

To discuss certain other less well-known domesticated breeds would probably be wearisome to the reader. Sufficient has been said to indicate that the origin of the animal commonly known as *Felis domestica* is probably a composite one, and that it is scarcely entitled to be called a single species.

If the views of Prof. Martorelli be found substantially correct, the following will be the lines of evolution: Firstly, we have the ancestral type of the Egyptian cat (*F. libyca*), inhabiting North-Eastern Africa and a considerable part of Europe during the Pleistocene, and perhaps a part of the Pliocene, period. From this original species originated in the eastern side of the Old World the Mediterranean cat (*F. mediterranea*) and the wild cat (*F. catus*). When man became dominant he produced the European domesticated breed, either directly from the typical Egyptian cat or from its variety the Mediterranean cat. And this original domestic breed soon became crossed with its immediate cousin the wild cat.

On the other hand, in the East the original Egyptian cat gave rise to the jungle-cat (*F. chaus*), the steppe-cat (*F. caudata*), and presumably, therefore, that near ally of the latter, the Indian desert-cat (*F. ornata*). From the latter are derived the spotted Indian domesticated cats, while the fulvous domesticated breed of the same country has been produced by a cross with the jungle-cat. Both these

are now largely crossed with their somewhat remote cousin, the striped domesticated cat of Europe.

The Persian cat, as we have seen, may probably be derived from Pallas's cat, which has no sort of connection with the Egyptian cat; and the cross between the Persian and European "tabby," now so common, is consequently a very mixed breed indeed. Finally, it is probable that the Siamese cat has an ancestry totally distinct from that of all the rest.

THE PEDIGREE OF THE DOG

THE number of breeds and varieties of the domesticated dog is so great that it is at first rather hard to believe that all are descended from a few wild types. Nevertheless, the differences between these are not greater than those met with among domesticated pigeons and fowls, which are known to be respectively descended from the wild pigeons of Europe and the jungle-fowls of Asia. A peculiarity of most domesticated dogs is their power of barking, which seems to be entirely unknown among all wild members of the family *Canidae*, even the semi-domesticated dogs of the Eskimo being unable to bark, as are the dingos of Australia. But if kept among barking dogs, both these breeds, and apparently also wolves and jackals, will soon learn to bark in a more or less thorough manner. Barking is, therefore, evidently an acquired habit; but that it affords no argument against the derivation of the domesticated breeds from the wild races is evident not only from the above instance, but also from the circumstance that the Asiatic jungle-fowl are unable to crow in the manner characteristic of their domesticated descendants. Several traits—such as turning round several times on a hearthrug in order to make a hole before lying down, and scratching up earth with their fore-feet and throwing it backwards with the hind pair, common to wolves and jackals—are inherited by even the most domesticated of domestic dogs; and these are evidently of great value in helping to

trace the ancestry. A German writer, the late Prof. L. Fitzinger, considered that domesticated dogs might be divided into seven well-marked groups, which included close upon a couple of hundred of more or less well-marked breeds and varieties. Other authorities are, however, of opinion that the number of main groups might be reduced to half a dozen, these including wolf-like dogs, such as the Eskimo breed, the various kinds of greyhounds, spaniels, hounds, mastiffs, and lastly terriers.

All who have written on the subject are in accord in regarding all domesticated dogs, with the exception of the Australian dingo, as constituting but a single species—the *Canis familiaris* of Linnaeus. But if it be true, as seems probably the case, that domesticated dogs trace their ancestry to more than a single wild species, it will be obvious that *Canis familiaris* cannot in any sense be regarded as equivalent to an ordinary wild species; and that, properly speaking, if this were possible, the various true breeds ought to be affiliated to the wild species from which they are respectively derived. Still, for practical purposes, the ordinary classification may be accepted, if it be remembered that *Canis familiaris*, like *Felis domestica*, is in all probability a "convergent" species.

By naturalists all the members of the dog tribe are included in the great family *Canidae*, which thus embraces wolves, jackals, foxes, wild dogs, the African hunting-dog, the long-eared fox of the Cape, and the bush-dog of Guiana. Somewhat different views are entertained as to how many of these should be included in the typical genus *Canis*, but this is a matter which needs no consideration here, and we may accordingly proceed to eliminate from the list those groups which have certainly no claim to be on the ancestral line of the domesticated breeds.

First of all we may dismiss the rare South American bush-dog (*Speothos*), which is a small somewhat fox-like creature with a short tail and teeth of a quite peculiar type. Equally far removed from the line are the long-eared Cape fox (*Otocyon*) and the African hunting-dog (*Lycaon*), the former having more teeth than the domesticated breeds, while the latter has fewer toes. Next we may eliminate the wild dogs of Asia, which are frequently separated from the other members of the family under the name of *Cyon*, as all these have one pair less of cheek-teeth in the lower jaw, and therefore obviously cannot be the ancestral stock, as an organ once lost cannot be replaced. Rather nearer to the domesticated races are the foxes and fennecs (*Vulpes*), exclusive of the South American species commonly so called. But if we examine the skull of the British or any other species of true fox, an important difference will be found between it and the skull of any domesticated dog, wolf, or jackal. This difference is best displayed in the shape of the projecting process of bone forming the hinder border of the socket of the eye; this process in a fox being distinctly concave, whereas in all the others it is highly convex.

We thus arrive at the conclusion that the only existing members of the family that can possibly be the ancestors of the domesticated breeds are wolves, jackals, the Australian dingo, and certain South American species which, although commonly termed foxes, are really more closely allied to the jackals and wolves; and it is further obvious that the only extinct species which can claim a place in the line of descent are those having skulls and teeth of the wolf type—in other words, species of the genus *Canis* in its restricted sense.

Before proceeding farther, it may be mentioned in con-

firmation of the foregoing views that in all the late Mr. Bartlett's long experience at the "Zoo" he never met with a well-authenticated instance of a fox interbreeding with either a dog, wolf, or jackal; and although newspaper reports have subsequently mentioned a hybrid between a fox and a dog, it is obvious that such crosses are, at the most, of extreme rarity.

On the other hand, when suitably matched, there is no sort of difficulty in obtaining crosses between wolves and jackals and domesticated dogs; and it is a well-known fact that the Eskimo are constantly in the habit of crossing their sledge-dogs with wolves in order to impart strength and stamina to the breed. Indeed, Eskimo dogs are so closely related to wolves that there can be no question that they are descended from them, Mr. Bartlett remarking that they are undoubtedly "reclaimed or domesticated wolves."

This being so, Eskimo dogs should properly be called *Canis lupus* instead of *Canis familiaris*; and if it could be shown that all domesticated dogs have the same ancestry, the former name should stand for all. On the other hand, as was long since pointed out by that acute observer the late Sir John Richardson, the Hare Indians of North America, who inhabit a zone lying considerably to the south of Eskimo territory, have dogs very closely resembling the small American prairie-wolf, or coyotè, which is the wild species most commonly met with in their territory. And it may be affirmed with a considerable degree of confidence that the Hare Indian dog presents the same relationship to the coyotè as is borne by the Eskimo dog to the wolf. Accordingly, if we base our nomenclature on descent, the former breed ought to be called *Canis latrans*.

We have now arrived at the conclusion that domesticated dogs trace their descent back to at least two wild species, and we may quote once more from Mr. Bartlett, who writes as follows: "All wolves, if taken young and reared by man, are tame, playful, and exhibit a fondness for those who feed and attend to them. The same may be said for all the species of jackals. This being so, it is highly probable that both wolves and jackals were for many ages in the company of man, and that owing to this association the different species of these animals may have bred together and become domesticated."

This introduces the various species of jackals into the problem, and since there is a marked similarity between certain domesticated breeds of dogs and jackals, while the native domestic dogs of nearly every country present a more or less markedly striking likeness to one or other of the indigenous wild *Canidae* of the same district, there can be little doubt that *Canis familiaris* has a multiple origin, and that man has tamed various wild races at different times in different parts of the globe. And it will be obvious that where the domestication has taken place in very remote ages, and there has been much subsequent mingling and shifting of population, the resemblance to the wild species will be the least marked. On the other hand, where the taming has been comparatively recent, where there has been no shifting of population, or where the original breed was best adapted to the needs of its masters, then the resemblance to the original stock will be most likely to persist longest.

To give a few instances. Mr. Blyth was much struck with the marked resemblance between many of the Indian pariah dogs and the wolf of the same country—a resemblance to which I can testify from my own experience. In

many parts of Europe the wolf-dogs and sheep-dogs are remarkably like the races of wolves inhabiting the same districts; and the black Florida wolf-dog is strikingly similar to the black wolf of that country. Sheep-dogs may therefore be included among the breeds descended from wolves, and are some of those which have undergone the least amount of modification from the parent type. On the other hand, when we proceed to South-Eastern Europe and the South of Asia, we meet with breeds of dogs so like the jackals of the same districts that it is hard to believe they are not very closely related. South Africa is the home of that very peculiar species, the black-backed jackal, and in many districts dogs are met with showing a marked resemblance in form and coloration to that species, although having lost the deep black patch on the back from which it takes its name. It has also been noticed that certain domesticated breeds in South America are so like the *Canis azarae* of the same region as to lead to the belief that the one is the descendant of the other.

From these and other considerations Darwin was led to the following conclusion: "It is highly probable that the domestic dogs of the world are descended from two well-defined species of wolf—namely, *C. lupus* and *C. latrans*—and from two or three doubtful species—namely, the European, Indian, and North African wolves; from at least one or two South American canine species; from several races or species of jackal; and perhaps from one or more extinct species."

In all the above-mentioned instances the domesticated breeds belong either to half-savage races, or are those which, like wolf-dogs, sheep-dogs, and pariah dogs, have departed but little from the original wolf or jackal type. In some cases we have seen these breeds are kept true

by crossing with the original stock, and several of them may be comparatively modern. Such breeds throw no light on the origin of the more specialised domesticated breeds, such as mastiffs, spaniels, hounds, and terriers, all of which are quite unlike any wild species, and have evidently undergone a long course of modification, dating back in some cases for hundreds if not thousands of years. To trace the pedigree of such breeds is probably quite impossible, although the investigations of archaeologists and palaeontologists are most important in proving the extreme antiquity of the domestication of the dog. Ancient monuments show that at a very early period domesticated dogs were differentiated into two very distinct breeds—namely, those which hunt by scent like hounds, and those which, like greyhounds, depend upon sight in the chase; and when once these were established further modifications would doubtless have soon arisen if attention was paid to breeding. Many of these breeds and strains were doubtless produced by crossing those derived from different wild species, by which means all trace of the original ancestry would gradually have been lost.

In the Roman period not only were sight-hounds and scent-hounds fully differentiated, but there were also various kinds of lap-dogs and house-dogs, although none quite like our modern breeds. Even as far back as about 3000 B.C. Egyptian frescoes show not only greyhound-like breeds, but one with drooping ears like a hound, and a third which has been compared to the modern turnspit; while house-dogs and lap-dogs came in soon afterwards. Whether any of these are the direct ancestors of modern breeds, or whether all such have been produced by subsequent crossing, is a very difficult question to answer, more especially when we recollect that if an ancient Egyptian artist had

to draw the portrait of a modern dog it would be very doubtful whether it would be recognised by its master or mistress.

But the record of the antiquity of domesticated dogs does not even stop with the earliest known Egyptian monuments. Not only were such breeds known in Europe during the Iron and Bronze Ages, but also during the antecedent Neolithic or polished stone period. These have been described by the late Prof. Rütimeyer and Dr. Wöldrich; and those who are acquainted with the difficulty of distinguishing between some of the living species by their skulls alone will understand the laborious nature of the task. Still, these authorities appear to have made out that the Swiss Neolithic dog (*Canis palustris*) had certain cranial resemblances to both hounds and spaniels, and thus indicated an advanced type, which is considered to have been derived from neither wolves nor jackals, but from some species now extinct. Certain other breeds have also been recognised from the superficial deposits of the Continent; and if, as is very likely to be the case, any or all of these races are the forerunners of some of the modern breeds, it will readily be understood how complex is the origin of the mixed group which we now call *Canis familiaris*. Even in South America there is evidence of the great antiquity of domesticated dogs, for I have described a skull from the superficial deposits of Buenos Aires, which, though apparently contemporaneous with many of the wonderful extinct mammals of the Pampas, yet shows unmistakable signs of affinity with domesticated breeds, although the precise relationship has not yet been established.

Perhaps, however, the greatest puzzle in the group is the dingo, or native dog of Australia, which has been

regarded as a distinct species, under the name of *Canis dingo*, and is found both in the wild condition and also in a semi-domesticated state among the natives. In appearance it is somewhat like a rather small wolf, with pointed ears and a bushy tail; its usual colour being rufous tawny, although some individuals are much paler, and others so much darker as to be almost black.

As, with the exception of numerous peculiar kinds of rats and mice and a few bats, Australia is populated with marsupials to the exclusion of ordinary mammals, it was long supposed that the dingo, which appears to be very closely related to the Indian pariah dog, was introduced by man. But of late years a quantity of its fossilised remains have been dug up in various parts of Australia in association with those of gigantic kangaroos, diprotodons, and other extinct marsupials, in beds where there appears to be no evidence of the presence of man. And it has consequently been urged that the dingo is as truly indigenous to Australia as are kangaroos and wombats. There is, however, great difficulty in accepting this view, as the rodents might have obtained an entrance by being carried on floating wood, or by some other means of transport; and if the dingo travelled by land to Australia, other placental mammals ought to have accompanied it. Moreover, the dingo is neither a wolf nor a jackal, but in all essential characters a true dog of the domesticated type, which seems scarcely separable from *Canis familiaris*. We have, therefore, the further difficulty of determining, if it be really a distinct species, from what Asiatic form it took its origin. This difficulty is enhanced when we recollect that throughout the Malay countries there are no wild species of the restricted genus *Canis* known, the so-called wild dogs of Java and Sumatra belonging, as already said,

to *Cyon*. It is true that Messrs. Kohlbrugge and Jentink have recently described a dog from the Tennger Mountains in Eastern Java under the name of *Canis familiaris tenggerana*, which is apparently a semi-domesticated race living in a partially wild condition. When more is known about it, and its resemblances or dissimilarities to the dingo are fully indicated, there may be a possibility of some rays of light being shed upon the problem of the introduction of that animal into the Antipodes.

TWO FASHIONABLE FURS

To those who are of an observant nature, an afternoon's stroll through any of the fashionable London thoroughfares during any of the past few winters must have revealed the prevalence of a fashion for the beautiful furs respectively known as blue fox and white fox. The skins of these animals are either worn entire as boas (or "necklets," as I am told they are called by ladies) or made up as muffs, and in either condition are strikingly beautiful. Blue fox has long been highly esteemed as a fur, skins selling for between ten and fourteen guineas ten years ago. White fox, on the other hand, has only during the last few years been appreciated as its beauty deserves, the price per skin having risen from between half a crown and sixteen shillings and sixpence during 1891 to three or four guineas, or even more, during recent years.

But it is not the price of either the blue or the white skins I propose to discuss in detail in the present article. The circumstance to which I desire to draw the attention of my readers is the very remarkable one that both the blue and the white skins belong to one and the same kind of animal. At first sight this may seem, perhaps, a fact of no special interest or importance. For, as we all know, certain species of mammals, such as the stoat or ermine, the mountain-hare, and the lemming, are normally white in certain parts of their habitats in winter and dark-coloured in

summer. Again, many mammals vary to a great extent in coloration according to locality, so that there may be dark-coloured and light-coloured races inhabiting different localities. The most striking instance of this is, perhaps, the big-horn wild sheep of North America, which in the Rocky Mountains is a khaki-coloured animal with a white rump, but in Alaska is nearly pure white all over throughout the year. It is true, indeed, that American naturalists prefer to regard the big-horns of the Rocky Mountains and Alaska as distinct species rather than local races of a single variable animal, but for our present purpose such slight differences of opinion do not really affect the case one way or the other.

That white fox and blue fox skins are not (as was once supposed to be the case by some naturalists) the summer and winter coats of the same individual animals will be apparent by a comparison of furs of the two descriptions worn by our lady friends. Both descriptions have the same long thick hair, with a woolly under-fur at the base, and are evidently the winter coats of the animals to which they respectively belong. Indeed, with all long-haired animals of the northern parts of the Old World, with the possible exception of the Polar bear, it is the winter coat that is alone valued by the furrier.

That blue and white foxes are not local races of the same species (or distinct species) is evident from the fact that in certain districts both occur together, although in other localities (as in Iceland, where all the foxes are blue) only one form may be met with. It is, indeed, possible that in some cases blue and white cubs may appear in the same litter. For instance, Prof. A. S. Packard, in his work entitled "The Labrador Coast," states he was informed by a native "that the white and blue fox littered

together, but that the blue variety was very rare." Again, in answer to inquiries on this subject, Dr. Einar Lönnberg, of Upsala, whose observations are based on personal experience, wrote to me as follows:—

"The 'blue' foxes are uniformly dark-coloured summer and winter, and do not change to white at any time. In the summer they are very dark—dark brown, in fact; in winter they are also dark, but more bluish. The individuals which turn white in winter are during the summer ashy grey on the upper-parts and limbs, but have the tail, under-parts, more or less of the flanks, and the ears and muzzle white. The distribution of the grey and white is, however, subject to individual variation. The 'blue' fox is, in fact, merely an individual variety of the white one. Both breed together, and sometimes there are dark and light individuals in the same litter. A friend of mine observed on Bear Island a pair in which the female was white and the male blue. In Iceland it is stated that all the Arctic foxes are blue."

More precise information is required on the subject of their interbreeding, but it is quite certain that the blue fox and white fox of the furrier are only individual phases of the winter coat of a single species of fox.

Although it is stated that white specimens are occasionally met with in summer, the white phase of the Arctic fox (as the species is called) normally assumes a dark coat in summer. The difference between the winter and summer coats of this phase of the species is well illustrated by a couple of specimens which have recently been placed in the central hall of the Natural History branch of the British Museum. In the case containing the mountain-hare, ptarmigan, stoat, and weasel in their white winter dress has been introduced a specimen of the Arctic fox in

the same coat. In contrast with this, the case in which are placed the above-mentioned animals in their dark summer costume contains a specimen of the white phase of the Arctic fox in its dark summer coat. In this specimen, the hair (which is much shorter than that of the example in the winter dress) is dirty rufous brown shading into grey on the upper-parts and outer side of the limbs, and yellowish white below. In other examples the colour of the upper-parts is greyer, while the under-parts are nearly pure white. Sometimes also, it is stated that grey hairs are largely mingled with the white winter coat, so that we have a more or less marked tendency towards the blue phase even in the winter dress. In all cases the muzzle remains black, and it is stated that there may occasionally be a black tail-tip in the white winter dress. I have not seen a "blue fox" in the summer dress, but am told that the coat is then chiefly distinguished from its winter condition by its much shorter hairs and less pure blue colour.

Of course, the so-called "blue" of even the best skins is a slaty or French grey rather than a blue in the proper sense of the word, and in many instances it tends to drab or dark purplish. Alaskan blue fox, which is somewhat coarse in the texture of the fur, has this purplish or sooty tinge most strongly developed, and at one time was specially valued on this account, although of late years the lighter varieties seem to have been chiefly in demand.

Lest any of my readers should be led to think that the Arctic fox is a near relative of the common species, it may be well to state, before going any farther, that it is a very distinct animal indeed. Apart from its coloration, the most distinctive features of the species are to be found in its short, rounded ears (which look almost as

though they had been cropped), moderately sharp muzzle, very long and bushy tail, and the coat of hair on the soles of the feet. From this latter feature the species takes its name of *Canis lagopus*; the object of the hairy soles being, of course, to afford the animal a firm foothold on the ice and frozen snow on which it passes so much of its time. In having two distinct colour-phases at all seasons of the year, which may be met with in the same locality, the Arctic fox stands practically unique among mammals. It is true that black-maned and yellow-maned lions may be occasionally met with in the same litter, while black leopards and black jaguars occur now and then among litters of cubs of the ordinary colour. But neither of these instances is exactly on all fours with the case of the Arctic fox. With regard to the lion, it has now been ascertained that the black-maned and tawny-maned specimens belong, in most cases at any rate, to distinct local races; and it is most probable that when light- and dark-maned cubs are met with in the same litter, it is due to crossing between two of these races. Black or melanistic leopards and jaguars, on the other hand, are more analogous to albinoes, and generally occur in hot and damp climates. The black phase of the common water-vole, found high up in many British valleys, is an instance somewhat analogous to that of black leopards, being apparently due to climatic conditions, and therefore not strictly comparable with the case of the Arctic fox.

Many invertebrate animals exhibit two or more distinct phases—generally differing to a certain extent from each other in details of form or structure—and to such the name of dimorphic animals is technically applied. Naturalists have agreed to designate the Arctic fox by the same title, although, were it not that it might be taken to

convey an altogether different meaning, the term "dichroic" would be more appropriate, seeing that the difference between the two phases is solely one of colour, and has nothing to do with shape or structure. Using, then, the term "dimorphism" as indicative of the existence in one animal of two distinct colour-phases totally unconnected with either locality or season, the Arctic fox appears to be the only mammal to which this designation can be properly applied.

The reason for this remarkable dimorphism in the Arctic fox is hard indeed to discover, and no satisfactory explanation of the puzzle appears hitherto to have been offered. It is almost unnecessary to say that the reason why Arctic and sub-Arctic animals turn white in winter is that they may be as inconspicuous as possible in their environment of snow and ice. And if blue foxes were met with only in countries where snow lies but a short time in winter, while white ones occurred solely in more northern lands, some clue to the puzzle might be forthcoming. But, as a matter of fact, this is not the case.

The distribution of the Arctic fox is circumpolar, extending in the New World about as far south as latitude 50°—that is to say, nearly to the southern extremity of Hudson Bay—and in the Old World to latitude 60°, or, approximately, to the latitude of Christiania and the Shetland Isles. Northwards the species extends at least as far as Grinnell Land.

In Iceland all the Arctic foxes appear to belong to the blue phase, and as that island is far to the south of many portions of the habitat of the species, it might be thought that this is the reason why the white phase is unrepresented there. But that island is far north of the line where the mountain-hare and the stoat begin to assume

a white winter livery; and if it is essential for these species that they should assimilate their colour to that of their surroundings, why is it not equally so in the case of the Arctic fox?

Again, although, as already mentioned, blue foxes are rare in Labrador, in Alaska they are comparatively common, and the same is the case in Greenland, whence the Royal Greenland Company imported 1,451 skins to Copenhagen in 1891. And if it be essential for animals to turn white in winter in any country in the world, it is surely Alaska. It is difficult to ascertain the proportion of blue to white foxes in either Alaska or the Pribiloff Islands, but it is certain that in both localities the two phases are found together, living apparently under precisely the same physical conditions.

As regards the islands last named, Mr. Elliot, in his work on "The Seal Islands of Alaska," writes that "blue and white foxes are found on the Pribiloff Islands, and find among the countless chinks and crevices in the basaltic formation comfortable holes and caverns for their accommodation and retreat, feeding upon sick and pup seals, as well as water-fowl and eggs, during the summer and autumn, and living through the winter on dead seals left on the rookeries and their carcases on the killing-grounds."

This account, then, fully establishes the fact that blue and white foxes occur in regions where, according to all accepted rules, there ought to be none but white individuals during the long and dreary winter. It gives, however, no definite clue to the reason for the strange association.

There is, however, a description of the habits of Arctic foxes in Grinnell Land given by Colonel Fielden, in his

"Voyage to the Polar Sea," which may possibly throw some light on the subject, although, unfortunately, it does not tell us whether blue as well as white foxes are found in that region. After referring to the numbers of lemmings to be seen looking out from the mouths of their holes, or feeding in the vicinity, the author proceeds as follows :—

"We noticed that numerous dead lemmings were scattered around. In every case they had been killed in the same manner—the sharp canine teeth of the foxes had penetrated their brain. Presently we came upon two ermines killed in the same manner. . . . Then, to our surprise, we discovered numerous deposits of dead lemmings; in one hidden nook under a rock we pulled out a heap of over fifty. We disturbed numerous 'caches' of twenty and thirty, and the earth was honeycombed with holes, each of which contained several bodies of these little animals, a small quantity of earth being placed over them. In one hole we found the greater part of a hare hidden away. The wings of young brent-geese were also lying about; and as these birds were at this time just hatching, it showed that they must be the results of successful forays of prior seasons, and consequently that the foxes occupy the same abodes from year to year. I had long wondered how the Arctic fox exists in winter."

Now, it will be evident that in this instance the foxes killed the prey stored up for winter use while they were in the dark summer coat. And since in winter, when the birds have left and the lemmings have retired to the depths of their burrows, they have no game to capture and no enemies to fear save Polar bears (which would not be likely to do them much harm), it would appear to be a matter of no consequence whether their coats be

dark or light. Consequently, it seems a possible explanation of the phenomenon under consideration that the blue phase of the Arctic fox indicates a reversion to the ancestral coloration of the species, due to the fact that no advantage is to be gained by the assumption of a white livery. Such reversion might well take place only in certain individuals of a species, and would probably tend to become more or less completely hereditary. Before such an explanation can, however, be even tentatively accepted, it is necessary to ascertain whether the blue Arctic foxes of Iceland are in the habit of making winter stores of provisions. If they are not, but hunt their prey in winter, the theory will not hold good.

For animals which hunt their prey in winter, or are themselves hunted, it would seem essential that they should be white even in the highest latitudes, where the long Polar night lasts three-quarters of the year, since in the bright starlight—to say nothing of moonlight—they would, if dark-coloured, be almost as conspicuous on the snow as in daylight.

As regards the number of Arctic fox skins which find their way into the market, Mr. W. Poland, writing ten years ago, states that from twenty-five thousand to sixty thousand of the white phase were then annually imported from Siberia, the greater number of these coming to Leipsic. The fur of these is of a rather coarse quality, quite different from that of the fine-haired Greenland skins. In 1891 about nine thousand white skins were imported by the Hudson Bay and Alaska Companies, and nearly one thousand by the Royal Greenland Company. Of blue skins, about two thousand were annually imported into London by the Alaska Company, and some five hundred to Copenhagen by the Greenland Company, although in 1891 the number

of skins sold by the latter body reached 1,451. It is noteworthy that in the fur trade Greenland blue fox skins are well known to be of the same fine-haired quality as the white skins from the same locality, while the Alaskan blue skins are equally coarse-haired. Consequently there is presumptive evidence of the existence of a Greenland and an Alaskan race of the species; and, as a matter of fact, American naturalists have recently split up the Arctic fox into several distinct forms, some of which are regarded as species.

THE SEA-OTTER AND ITS EXTERMINATION

A FEW summers ago a gentleman with whom I am acquainted spent his holiday in shooting and fishing on the west coast of Ireland, and in the course of his trip procured several fine otter-skins, taken in some of the bays of that picturesque district. As these otters lived in the sea, my friend, who does not profess to be a naturalist, jumped to the conclusion that they were sea-otters; and as he had heard of the value attaching to the pelts of the latter animal, was not a little elated at having obtained such *spolia opima* at such small cost. And it came somewhat as a shock to him when he heard that otters living in the sea were not necessarily sea-otters in the zoological sense of the term, and that to procure specimens of the latter he would have to journey to the shores of the islands and continents of the North Pacific.

Now although it is improbable that many of my readers would be likely to confound an ordinary otter which has taken up its residence on the coast with its truly marine cousin, yet before entering upon the consideration of the habits and impending extermination of the latter, a few words relating to some of the leading points of distinction between the two animals will scarcely be wasted.

Ordinary otters, then (of which there are numerous species, ranging over nearly all the habitable parts of the globe where water is plentiful), are animals nearly allied

to the martens and weasels, but specially modified for the needs of an aquatic life, and furnished with teeth adapted to seize and hold the slippery prey on which they subsist. Since, however, they are much less exclusively aquatic than seals, spending much of their time on shore, their structural variations from the ordinary mammalian type are far less marked than is the case in the members of the latter group. The toes, for instance, are not webbed, and neither pair of limbs shows a tendency towards a paddle-like form, although both are relatively short. In addition to this shortening of the limbs, the points chiefly noticeable as adaptations for swimming are the great breadth and flatness of the head, the small size of the ears, the absence of a distinctly defined neck, the elongated and flattened body, moderately long and powerful tail, and the denseness and softness of the fur. As regards the teeth, it will suffice to mention that while these conform to the general marten type, the hinder ones are remarkable for the greater extent of grinding surface, the last upper molar especially being distinguished by the peculiarly squared form of its crown. In all these teeth the cusps are remarkably strong and sharp, and thus suited for piercing the scales of fish.

Contrast these features with those distinctive of the sea-otter—which, by the way, is the only representative of its kind. In addition to its being a shorter- and thicker-bodied creature, with a still broader muzzle and no definable neck at all, the sea-otter is at once distinguished by the structure of its hind-feet, which are fully webbed, and so lengthened and expanded as almost to simulate paddles ; the extremities of the toes being, it is said, turned down beneath the sole when on land. The tail, too, is thicker, less tapering, and more flattened than that

of an ordinary otter. The skin invests the body as loosely as a pillow-case covers a pillow; and the dark brown fur is unrivalled for its softness, depth, and density. But even more remarkable is the difference between the cheek-teeth of the two animals. In place of the sharply cusped grinders of the common otter, the marine species has the crowns of these teeth surmounted by smooth ill-defined bosses, separated by narrow crack-like lines; the one type having been aptly compared to freshly chipped flints, and the other to water-worn pebbles. Clearly such structural differences must be correlated with a totally different description of diet, and, in place of being a fish-eater, the sea-otter subsists by grinding up sea-urchins, clams, mussels, and such-like, shells and all.

Had we living animals alone to guide us, there might be some hesitation in saying that the sea-otter is a highly modified offshoot from the stock of the ordinary otter, but the evidence of extinct forms indicates the probability of this being the case. Fossil remains of true otters occur comparatively low down in the series of rocks belonging to the Tertiary period; and somewhat higher in the scale are found, both in Europe and India, those of an extinct genus (*Enhydriodon*), in which the cheek-teeth are to a certain extent intermediate between the types respectively characteristic of the ordinary and the sea-otters. These intermediate extinct otters appear, however, to have been fresh-water animals, so that purely marine habits would seem to have been acquired only with the advent of the modern sea-otter.

The geographical range of the latter on the American side formerly included Alaska, the Aleutian and Pribiloff Islands, Sitka, and Vancouver Island, and thus down the coast to California; while on the opposite shore it

embraced Kamtchatka and the Komandorksi and Kurile Islands.

Numerous accounts of the habits and capture of this valuable animal have been published as the results of the observations of naturalists and hunters on both sides of its habitat, many of these relating to times when it was still more or less abundant, and its pelts consequently did not realise the extravagant prices now current. The attention recently directed to the fur-seals of Bering Sea has resulted in equally important observations with regard to the sea-otters of the same region, and the results of some of these are recorded in a pamphlet issued by the Treasury Department of the Washington Government, drawn up by the Commandant of the Bering Sea Patrol Fleet, Captain C. L. Hooper. As in the case of the fur-seals, the same sad story of ruthless destruction and relentless persecution is unfolded; and while the animal has already been completely swept away from several of its original haunts, there is great danger of its complete extermination from this side of the Pacific unless adequate means for its protection are promptly devised and effectually carried into execution.

From the same report it appears that when the Russians first visited Alaska its shores literally abounded with sea-otters, which were relentlessly hunted and slain, affording a rich harvest to their captors. In consequence of this, after a period of about fifty years—that is to say, towards the close of the eighteenth century—a notable decrease in numbers was observable; and by the same date the otters, which were said to have swarmed on the Pribiloffs at the time of their discovery in 1786, had almost completely disappeared from these islands. From the close of he eighteenth century till the taking over of the country

by the United States, the Russian-American Company had the practical control of the Alaskan territory, and formulated regulations for otter-hunting, by which the total catch was limited and a restriction placed upon the number captured by individual natives.

In the earlier days the sea-otters were in the habit of coming ashore, both to feed on the sea-urchins and shell-fish thrown up by the tide, and also for the purposes of repose and breeding. The otters were either captured in nets or killed by means of spears or clubs. Only males were, however, then slaughtered; the hunters being taught to distinguish the females, even when in the water, by the difference in the colour and shape of the head and neck. And when hunting on shore the utmost care was taken to prevent disturbing the animals more than necessary, and also to leave as few traces as possible of human presence.

Notwithstanding these regulations, the sea-otters continued to diminish in number; and, in addition to the Pribiloffs, had already disappeared from certain districts at the date of the transference of Alaska to America. After this date, although the hunters for several years adhered to some extent to the old rules, the destruction became much more rapid, and all precautions for the preservation of the breed were ignored. Numerous cod-fisheries were established on some of the banks; and the people thus collected, together with the refuse left on the shore, rendered many districts unsuitable to the otter. Moreover, there were no regulations to prevent white men from killing as many animals as they pleased; and as the sea-otter was by far the most valuable inhabitant of the shores, it naturally came in for the largest share of attention.

Harassed on all sides—netted in the sea, clubbed and

shot on shore, its landing-grounds rendered uninhabitable by human presence as well as by the refuse of the fisheries and the decaying bodies of its own companions—the sea-otter, as might have been expected, has totally changed its original mode of life. Instead of hauling out on shore to feed, repose, and breed, it now sleeps and breeds on floating masses of seaweed, while its feeding-grounds are banks in some thirty fathoms of water. But even in these situations the unfortunate animals enjoy no peace, but are hunted and harassed by fleets of schooners from March till August. From many of its old habitats it has more or less completely disappeared, all the grounds to the west of Unimak Pass being practically deserted. On a few of the banks, indeed, a stray otter may now and then be captured at long intervals, but on others not a single head has been observed for the last ten years or so. At the present day most of the otters captured in the Aleutians are taken on the banks lying to the south-west of Kadiak. These banks are bounded on the north-west by the Alaska peninsula, on the north-east by Kadiak Island, to the south-east by the Trinity Islands, and to the south-west by the Semedi Islands.

Between the years 1873 and 1883 inclusive, the approximate number of sea-otters annually captured by the natives of the Aleutian Islands varied between 2,500 and 4,000. The latter number was exceeded in 1885, but from that year there has been a rapid decrease, as is shown by the following figures—viz., 1886, 3,604; 1887, 3,095; 1888, 2,496; 1889, 1,795; 1890, 1,633; 1891, 1,436; 1892, 820; 1893, 686; 1894, 598; 1895, 887; 1896, 724.

This very heavy numerical decrease has been accompanied by an equally marked rise in the price of the skins. In 1888 the average price per skin was £21 10s.,

in 1889 it had increased to £33, and in 1891 to £57, since which date the price has again risen. For specially fine skins £88 was considered a record price some years ago, but now £100 is by no means uncommon, and £200, and even £225, have been paid for unusually splendid specimens.

As regards the methods of capture, clubbing and spearing are probably the least wasteful, few, if any, of the animals thus killed being lost. The gun is less satisfactory, as many wounded animals escape to die a lingering death. But the most wasteful of all is the net. Unless the animals be removed from the net within a few hours after death their skins are irretrievably ruined by the attacks of the myriads of minute crustaceans which swarm in the Arctic seas. Netting can be effected only in stormy weather, the nets being stretched from the shore to some convenient rocks; and frequently it is impossible to visit them for days together, when such captures as they may contain are valueless.

But the great diminution in the numbers of the sea-otter, although bad enough, is by no means the most serious element in the matter. Ever since the Russians took possession, hunting the sea-otter has afforded the chief means of livelihood to the Aleutian islanders. On this point Captain Hooper writes as follows: "The decrease in the yearly catch has already brought some of the settlements to the verge of want, and if they are allowed to become exterminated, actual suffering and even starvation can only be averted by Government aid. Properly protected and reserved exclusively for the use of the natives, the otter, while it can probably never be brought up to its former numbers, can be preserved from extermination, and will furnish a means of subsistence for these people for many years."

Although there is some little doubt in the matter, it appears probable that the whole of the present haunts of the sea-otter are within the territory of the American Government, and if this be the case there will be no need for an international agreement. Captain Hooper has compiled a code of regulations for provisional acceptance by the Government, and as these appear in every way admirably suited to effect the object for which they were drawn, it must be the earnest hope of every naturalist that they will be sanctioned and put into operation with the least possible delay.

A GIANT AMONG SEALS

FEW generalisations have taken a firmer hold of the popular imagination than the notion that the animals of to-day bear no sort of comparison with their predecessors of the past in respect of bodily size, and that, so far as the giants of the animal kingdom are concerned, we are living in a dwarfed and impoverished world. Like most popular conceptions, this idea contains a considerable element of truth mingled with a large amount of misconception. In the first place, there is no accurate definition of what is meant by "the past." If it mean only those epochs of the earth's history previous to the advent of man, it is unquestionably inaccurate. If, on the other hand, it also embrace the prehistoric portion of man's sojourn on the globe, it has scarcely a claim to be regarded as a fair or accurate statement of the true state of the case, seeing that the extermination of a very considerable percentage of the large animals of the epoch in question has been the work of man himself—a work, unhappily, which is still proceeding apace.

But, in addition to this, the animals of one geological epoch are very frequently confounded with those of another, so that dinosaurs and mosasaurs, ichthyosaurs and plesiosaurs, mastodons and mammoths, and glyptodons and ground-sloths are often spoken of as if contemporaries and inhabitants of the same country.

If such were really the case, we should indeed be living in an impoverished epoch of the world's history; but if we take the term "present" in not too narrow a sense, and also bear in mind that Europe, and such other parts of the world as have been more or less thickly populated for untold ages, scarcely form a fair basis of comparison, it will be manifest that the idea in question is to a considerable extent due to misconceptions and inaccuracies of the nature of those referred to above.

It is true that in certain portions of the world the larger forms of animal life disappeared at an epoch when man can scarcely be regarded as having taken a prominent part in their extermination; a notable example of this kind being South America, where the huge ground-sloths, toxodons, and macrauchenias of the latter part of the Tertiary epoch disappeared with seeming suddenness in what is to us an unaccountable manner. The extermination of the mammoth, the woolly rhinoceros, and the hippopotamus from Europe, although partly, perhaps, attributable to climatic change, has not improbably been accelerated by man's influence; and the same may be true with regard to some of the larger mammals of ancient India.

In the latter country we have, however, still the Indian elephant, the great one-horned rhinoceros, and the wild buffalo, which, although not actually the largest representatives of their kind, are yet enormous animals. In Africa the presence of animals of large corporeal bulk is more noticeable. Although the extinct elephant of the Norfolk "forest-bed" is stated to have been the biggest of its tribe, it is very doubtful if it was really larger than the living African elephant; and the so-called white rhinoceros, in the days of its abundance, was certainly not

inferior in point of size to any of its extinct relatives. The giraffe, again, which in the Mount Elgon district is stated to tower to twenty feet, is much taller than any extinct quadruped yet known to us; and the hippopotamus falls but little short of its ancestors of the Pleistocene epoch. The elands, again, are by far the largest of antelopes known at any period of the earth's history; and the ostrich, although not comparable with some of the New Zealand moas (which, by the way, were probably exterminated only a few centuries ago by the Maoris), is yet the largest member of its own particular group. Again, no fossil ape is known which is anywhere in the running as compared with a full-grown male gorilla. It is, moreover, probable, despite the old-world legends of giants, that man at the present day is, on the whole, a taller and finer animal than he ever was before.

Of course, there are certain cases where the animals of to-day cannot compare with some of their predecessors, and a case in point is afforded by the extinct atlas tortoise of Northern India, which (although its size has been vastly exaggerated) far exceeded in bulk its living cousins of the Galapagos and Mascarenes. This, however, may perhaps be accounted for by the larger area of its habitat.

Among the inhabitants of the ocean we shall find even more striking testimony as to the large bodily size (either absolute or relative) attained by many animals of the present day. Probably no mollusc was ever larger than the giant clam, whose valves measure a yard or more in length; and we have no evidence that the enormous cuttles and squids forming the food of the sperm-whale were ever rivalled in size during past epochs. The huge long-limbed crab of the Japanese seas, and the cocoanut crab

(which is but a marine creature that has taken to a terrestrial existence) of the islands of the Indian Ocean, are likewise probably the giants of their kind. At no epoch of the earth's history have we any record of an animal approaching in size the blue rorqual, with its length of between eighty and ninety feet, and its weight of, probably, at least as many tons. The sperm-whale and the Greenland right-whale were, at the time of their abundance, certainly the largest of their respective kinds; while the basking-shark has probably been unequalled in bulk by any of its predecessors. The great white shark of the present day is indeed considerably inferior in size to its cousins whose teeth now strew the floor of the Pacific; but these latter lived at no very distant period, and may possibly still survive. Walruses were never larger than they are at the present day, and the dugongs and manatis of the seas of our own days were fully as large as any of their ancestors of which we have ken; while the northern sea-cow of Bering Sea—exterminated only a century and a half ago—was in this respect far ahead of all other competitors.

The same is true with regard to the animal forming the subject of the present article—the sea-elephant, or, better, the elephant-seal—which so vastly exceeds in size all other members of its tribe, that even the largest sea-lions and walruses, when placed alongside its huge bulk, look dwarfs by comparison. But it is not only from its vast size that this seal is of more than ordinary interest, since it is remarkable for many peculiarities in structure and habits, approaching the eared seals (or sea-lions and sea-bears) more closely than is the case with any other of the true or earless seals. It has also, unhappily, an interest attaching to it on account of its impending extermination.

Elephant-seals frequent the shores of many of the islands of the South Seas, where they spend a long time on land during the breeding season, and also occurred formerly on the Pacific Coast of North America from Cape Lazaro to Point Reyes, California, where they are now practically extinct. As these Californian elephant-seals were completely isolated from those inhabiting the South Sea Islands, they are regarded by American naturalists as constituting a species by themselves; but since their distinction from the typical southern form is but slight, it seems preferable to look upon them in the light of an isolated local race. These seals never appear to wander south to the Antarctic pack-ice.

Our first definite, if not actual, knowledge of the elephant-seal seems to have been derived from a specimen brought to England by Lord Anson in 1744 from the island of Juan Fernandez, and the figure and account given in the "Voyage Round the World" of that great commander, where the species is called "sea-lyon." Lord Anson seems to have obtained a male and female specimen ("lyon" and "lyoness" he calls them), the former of which was stuffed and exhibited in the British Museum. What its dimensions were is now unknown—a somewhat unfortunate matter, since it was probably a full-grown adult male of larger size than any, or the majority, of those to be met with at the present day. After being exposed in the Museum galleries for considerably more than half a century, probably without any protection from dust and the still more mischievous hands of visitors (who then, as now, doubtless displayed an irresistible impulse to handle every accessible object), the specimen must certainly have shown marked signs of wear and tear. Anyway, if we may judge by the fact

that the jaws and teeth, which had been mounted in the skin, were sold by the Museum to the Royal College of Surgeons in 1809, the specimen appears to have been destroyed early in the last century. The aforesaid jaws and teeth are still preserved in the museum of the College of Surgeons.

Although many years later a female skin, presented by the Admiralty, was mounted and exhibited, from the date of the destruction of Lord Anson's specimen the British Museum till quite recently had no example of either skin or skeleton of an adult male of this giant seal to show the public. The deficiency has been made good by the generosity of Mr. Walter Rothschild, and the mounted skin and skeleton of two nearly adult males are now exhibited in the same case. Unfortunately the taxidermist has not been as successful as he might have been in the mounting of the skin; but nevertheless the specimens suffice to convey an adequate idea of the huge bulk of the creature and the leading peculiarities of its form.

It may be mentioned here that Anson's figure and description afforded to Linnæus his only knowledge of the species, and upon this evidence was established his *Phoca leonina*, the specific title being the equivalent of Anson's "sea-lyon." As the real sea-lions are totally different animals—eared seals, in fact—it is a great pity that this name was ever given, but, as being the earliest, it has to stand, and cannot be replaced, as proposed by some writers, by the more appropriate *elephantina*. As the elephant-seal differs very widely from the common seal and its immediate relatives, it could not, of course, with the advance of zoological science, be suffered to remain in the same genus, and it accordingly now typifies a group by itself under the name of *Macrorhinus leoninus*.

The generic title *Macrorhinus* refers to the most distinctive feature of the species, the peculiar trunk-like form of the muzzle of the old males. Not only do the male and female elephant-seal differ in regard to the form of the muzzle (the trunk being undeveloped in the last-named sex), but there is also a vast inferiority in the size of the latter as compared with the former. So marked, indeed, is this discrepancy, that an early observer is stated in Weddell's "Voyage" to have mistaken the two sexes for mother and young.

From the testimony of old "beach-combers" and others who have hunted them in their native haunts, it seems evident that the dimensions now attained by sea-elephants fall far short of those reached in the old days, when they abounded on the islands of the South Seas, and were permitted to grow to their full size. In the majority of text-books twenty feet is given as the length of the species; but it is definitely known that specimens at the present day frequently reach or exceed this length, and as none of these (as exemplified by the condition of the bones in the British Museum and other skeletons received of late years in England) appear to be fully adult, it seems well-nigh certain that old bulls must have grown to much greater size. Probably twenty-five feet would not be an undue estimate for the length of an adult male, and it is far from improbable that close upon thirty feet may have been reached in some cases.

Among the favourite haunts of the elephant-seal were the islands of the Crozet group, Kerguelen, and St. Paul, in the Indian Ocean, as well as Heard Island. In the South Atlantic these monsters formerly abounded on Tristan-da-Cunha, and nearer the American coast they are again met with farther south on the Falklands, South

Georgia, and the South Shetlands. On the eastern side of the Pacific they occur, as recorded by Lord Anson, on Juan Fernandez, and thence by way of the Marquesas to the Macquarie and other islands south of New Zealand, where the British Museum specimens were obtained. They were likewise common on the coasts of Tierra del Fuego and Southern Patagonia; and the occurrence of the isolated colony north of the equator in California has been already mentioned.

The trunk-like muzzle of the old bull sea-elephant, like the sac on the crown of the head of its relative the bladder-seal, is capable of inflation during periods of excitement, but at other times is small and relatively inconspicuous. Probably it is only when the animals are on shore, and more especially during the breeding season, that the trunk is inflated to its full extent. The sketch in Lord Anson's "Voyage," although true to nature in some respects, is in many ways a caricature, and it is only of late years that photographs have been obtained showing the true form of the animal. From these it appears that when on land the old bulls are in the habit of supporting the fore-part of the body on the front flippers and raising the neck and head into a nearly vertical posture, so that the latter is fully six feet above the ground. When the trunk is inflated to its fullest extent, the mouth is opened, and the animal emits a succession of terrific roars, which may be heard for miles.

In using its front flippers as a means of support to this extent, the elephant-seal is quite unlike the rest of the earless seals, and resembles the sea-lions and sea-bears. It also agrees with the latter group in the great superiority of the males to the females in point of bodily size. A third point of resemblance between elephant-seals and

eared seals is shown by their breeding habits, which are in many respects similar. On the Crozet Islands, for example, where they arrive about the middle of August, the old bulls secure a station for themselves. They do not, however, pass any long period without taking food, neither do they collect "harems" for themselves after the manner of the sea-bears and sea-lions; the females selecting a station for themselves some distance away. Soon after landing the females give birth to their young, which are at first black, and, although there is some discrepancy between different accounts, it seems probable that both sexes remain with their offspring till the latter are ready to enter the sea, which they usually do when about six or seven weeks old. When they have once taken to a maritime life, the young sea-elephants are said to grow at a prodigious rate; and, indeed, unless they take many years to attain full maturity, this must necessarily be the case.

As just indicated, the few accounts that have been given of the breeding habits of these seals by no means accord with one another, and this is the more to be regretted since, owing to the comparative scarcity of the species at the present day, it is very unlikely that an authentic history will ever be given to the world.

The extermination of this giant seal, so far as it has as yet gone, is a sad story, accompanied as it is by details of revolting and fiendish cruelty. In the eighteenth and the early part of the nineteenth century these seals were met with in thousands on most of their island haunts as well as on the shores of Patagonia, but the ease with which they could be killed, and the value of their hides and oil, soon led to a vast reduction in their numbers; and in many of their old breeding-places, such as the Falklands, they are either very scarce or are altogether exterminated.

On Heard Island they still survive in considerable numbers, owing to the difficulty of gaining access to their favourite breeding-ground, to reach which from the shore two glaciers have to be crossed. The difficulty of removing the oil and hides from such a locality has, however, been to a considerable extent overcome by driving the seals to sea during stormy weather, when they are compelled to seek an easier landing-place. In the Macquarie Islands elephant-seals appear to be still found in considerable numbers, but the difficulty, or impossibility, of obtaining a fully adult male tells its own tale as to the persecution to which the species is subject; and it is only too palpable that long before the middle of the present century elephant-sealing will have been abandoned as an unprofitable trade. But by that time we shall really be living in an impoverished world, so far as large animals are concerned.

THE FLYING-SQUIRRELS OF ASIA AND AFRICA

DESPITE the repetition of the statement as to their essential structural difference in almost every work on popular natural history issued to the public, few persons, save those who have made anatomy a special study, can be induced to believe that swallows and swifts are not closely allied birds. And it may be presumed that an equal degree of incredulity will prevail in the minds of most people when they are told that the two animals whose portraits are given in the plates accompanying have no sort of intimate relationship, being in fact much more widely sundered from one another than are such apparently dissimilar creatures as a squirrel and a beaver. An instance of this incredulity has indeed been actually published with regard to the figured species of the so-called African flying-squirrels, or, as they might be better termed, scale-tailed squirrels. Now this particular species of the group was sent home from Central Africa by Emin Pasha in the 'eighties, and described and figured under the name of *Anomalurus pusillus* by Mr. Thomas, of the British Museum, in 1887 and 1888. Three years later the figure (the one here reproduced) appeared in Major Casati's "Ten Years in Equatoria," with the following remarks :—

"The flying squirrel (*Mboma*) lives in the forests, almost always upon the branches of the trees, whence it throws

itself, expanding the membrane which joins the feet to the body, like a parachute. The skin is used as an ornament. I think it is identical with one very common in the island of Ceylon, which is almost tame."

The extraordinary misconception as to the affinities of the creature displayed in the last sentence of this quotation will be apparent when I say that the scale-tailed squirrels —whether furnished with a flying membrane or not—are absolutely restricted to Africa, where not a single representative of the true flying-squirrels of Asia and Europe exists.

The reason why these two very dissimilar groups of animals are regarded in popular estimation as near relatives is, of course, due to the fact that both are furnished with expansions of skin by means of which they are enabled to take flying leaps from bough to bough. Such flying membranes are developed in very few mammals, and the popular idea is that the presence of such a membrane must necessarily imply intimate affinity between all the forms in which it occurs. Hence not only are the African flying scale-tailed squirrels associated with the typical flying-squirrels, but the still more widely separated flying-phalangers of Australasia are likewise regarded as members of the same group.

In making such associations the public fail to recognise that similar structures may be produced in totally different groups of animals owing to their living under similar special conditions, or having peculiar habits of the same nature. In external appearance rodents belonging to different families, such as squirrels and dormice, may be very much alike; and if certain members of each group had acquired the same mode of life as the flying-squirrels, their similarity would probably have become still more noticeable. For unless

AN AFRICAN SCALE-TAIL IN FLIGHT.

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the whole skeleton of the fore-limbs be so modified as to form a wing, as in bats, it is difficult to see how ordinary mammals could be endowed with the power of taking flying leaps save by the development of an expanse of skin along the sides of the body in the manner which obtains in the true flying-squirrels, the scale-tailed flying-squirrels, the flying-phalangers, and, it may be added, the flying-lemurs.

The development of flying membranes in all these four groups of mammals has, in fact, taken place quite independently, and affords an interesting example of what is known as parallelism in development. Such parallelisms are due, so to speak, to the poverty of possibilities in the way of modification of animal structures. As already said, the simplest and most obvious way of endowing an ordinary four-limbed mammal with the power of taking flying leaps is by the development of lateral expansions of skin. Similarly, the only easily conceivable method by which a primitive short-limbed and many-toed hoofed mammal could be converted into one cut out for speed, like a horse or a gazelle, is by reducing the number of the digits and increasing the length of the lower segments of the limbs. Accordingly, we find parallelism in this respect between the horses and the zebras on the one hand, and the gazelles, antelopes, and deer on the other.

But the parallelism is by no means exact in this latter case, as indeed would be naturally expected if the lines of evolution were distinct; and the structure of the lower portion of the limb of a horse differs essentially from the same part in a gazelle.

Neither is the parallelism exact in the case of the two groups of flying-squirrels. In the flying-squirrels of Europe and Asia, such as the one depicted in the plate, the flying membrane, or parachute, is merely a lateral expansion

of the ordinary skin of the body, which extends outwards between the limbs as far as the wrists and ankles. In addition to the two lateral membranes, there is a narrow and inconspicuous one passing from each cheek along the front of the shoulder to the front of the wrist; and another, at least in the larger forms, connecting the two hind-legs and involving the base of the tail.

In general characters the parachute of the scale-tailed flying-squirrels of Africa conforms to the above type; and a superficial observer might say that the two were in all respects similar. A closer examination will, however, reveal the fact that the parachute in this group is supported by a process of cartilage projecting like a yard-arm from the elbow and extending to the edge of the membrane. As this is present in all the scale-tails (as we may call them for short, especially as they have no right at all to the title of squirrels) and absent in all the true flying-squirrels, it evidently indicates an important difference between the two groups.

A further important distinction between them is afforded by the presence on the under-surface of the basal portion of the tail of a series of overlapping horny scales, from which the African group takes both its popular title of scale-tail and its scientific name of *Anomalurus*. Evidently these scales are intended to aid in supporting the animals as they climb the boughs or stems of trees, and they are thus strictly analogous to the stiff tail-feathers of wood-peckers.

Yet another difference between the two groups is to be found in the structure of the crowns of their cheek-teeth. In ordinary squirrels the grinding surfaces of these teeth are surmounted by simple tubercles, which in some cases may be elongated into ridges. And a similar type of

THE WOOLLY FLYING-SQUIRREL OF ASTOR AND GILGIT.

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tooth-structure obtains in most of the flying-squirrels of Europe and Asia, although in the species shown in the plate the structure has become somewhat more complicated owing to the taller crowns of these teeth. In the scale-tails, on the other hand, a totally different type of tooth-structure obtains, the crowns of the molars being divided by transverse folds of enamel, after a fashion recalling that which prevails in certain South American rodents.

To the anatomist these differences are sufficient to render it quite certain that the scale-tailed flying-squirrels are, at most, but very remotely connected with their non-scaled namesakes of the northern hemisphere. The non-scientific person might, however, say that the "yard-arm" in the parachute and the scales on the tail are features which have been developed concomitantly with the acquisition of the parachute itself in certain species of flying-squirrels, and that, like the differences in the structure of the teeth, they are of no particular importance one way or the other in regard to the affinities of the animals in which they occur.

A few years ago it would have been impossible to produce absolutely decisive evidence as to the futility of such specious arguments. Recently, however, there has been discovered on the West Coast of Africa—that home of strange and primitive types of animal life—a rodent looking not unlike a large dormouse, which is really the "grandfather" of all the flying scale-tails. For this creature (known as *Zenkerella*), although without a parachute, has scales on its tail like *Anomalurus*, and teeth of the same type as the latter. Whether it is the actual form from which the flying scale-tails are descended, or whether it is itself a descendant of such ancestral form, may be left an open question, as it is one of no practical importance.

But it may be taken as certain that the flying scale-tails—of which, by the way, there are two distinct generic types (*Anomalurus* and *Idiurus*)—are the specialised descendants of a creature closely allied to, if not identical with, *Zenkerella*. It may further be affirmed with certainty that the evolution of the flying from the non-flying scale-tails has taken place in Africa. Whether, however, *Zenkerella* itself is an aboriginal African type, or an immigrant into the dark continent from the north, is a question difficult to answer at the present time.

Although the flying-squirrels of Europe and Asia have been known from time immemorial, their pedigree is not so easy to trace as is that of the scale-tails. Probably they were evolved from non-flying squirrels at an earlier date than that at which *Anomalurus* branched off from *Zenkerella* (or its prototype), as they appear to be represented by teeth in some of the earlier Tertiary deposits of Europe. It is therefore quite probable that even the generic types from which they trace their descent have died out. Nevertheless, it may be considered practically certain that they are descended from rodents more or less nearly allied to the true squirrels of the genus *Sciurus*. Their pedigree is therefore wholly distinct from that of their reputed cousins, the scale-tailed flying-squirrels of Equatorial Africa.

In appearance the true flying-squirrels, of which there are three distinct generic types, are very similar to ordinary squirrels, as indeed they are in their habits; their long flying leaps, during which they half float in the air by the aid of the parachute, being only an extension of the bounds taken by the ordinary red squirrel in its passage from tree to tree. Many of them are even more beautifully coloured than ordinary squirrels. Compared

with the latter, flying-squirrels are more strictly nocturnal animals; and their shrill scream is familiar to all travellers in the wooded districts of the Himalayas, as they are attracted by the light of the camp-fire.

The smallest members of the group are the pigmy flying-squirrels, typified by *Sciuropterus volans* of Eastern Europe and Siberia, and represented in North America by the closely allied *S. volucella*. They are pretty little creatures, with soft velvety fur and enormous staring black eyes. In all the pigmy flying-squirrels the membrane connecting the hind-legs and the base of the tail is absent; but, in compensation, the tail itself is broad, flat, and laterally expanded, so as to form an efficient aid in flight.

The typical and larger flying-squirrels, formerly known as *Pteromys* but now called *Petaurista*, are confined to Europe and Asia, having no transatlantic representative. Unlike that of the pigmy flying-squirrels, the tail of these rodents is cylindrical and comparatively thin, while, as already said, the parachute is fully developed between the hind-limbs.

In the last and finest representation of all the flying-squirrels—the species shown in the accompanying plate—the writer has a special personal interest. About the year 1878, when in Srinagar, Kashmir, he purchased the skin of a large flying-squirrel from a *chamra-walla* (tanner), who stated that it came from Astor or Gilgit, and that he had never previously seen its like. In due course this skin was brought to England, and converted into a perambulator-rug, in which capacity it was in use for several years, on one occasion narrowly escaping complete destruction by the jaws of a favourite pug-dog. At this period, it may be mentioned that the writer was

less well acquainted with mammals, so far as their exteriors are concerned, than he is at the present day. And although he had a suspicion that the skin in question was peculiar, no steps were taken to ascertain whether this was really the case. One day, however, in 1888, when paying a visit to the Natural History Museum, he was shown a living flying-squirrel from Astor, remarkable for its dark colour and bushy tail, which was pronounced to represent a then unknown species. A brief inspection was sufficient to render it evident that the skin serving as a perambulator-rug belonged to the same species as the living animal, although a much larger and finer individual. It was soon after presented to the Museum, and described, in conjunction with the complete specimen, not only as the type of a new species, but of a new genus, under the title of *Eupetaurus cinereus*. Owing to the splendid development of the tail in the flat skin, the figure of which a reproduction is given in the plate was partly drawn from that specimen.

The main reason for making the woolly flying-squirrel (as, from the nature of its coat, it has been called) the type of a genus by itself is afforded by the characters of its cheek-teeth, which differ from those of other members of the group by their tall crowns and imperfectly developed roots. This character indicates greater specialisation than the ordinary flying-squirrels. Unfortunately little or nothing is known as to the life-history of this splendid representative of the flying-squirrels, but there is some reason to believe that it dwells, at least to a certain extent, among rocks rather than in trees.

Although they do not properly come within the scope of the present article, a few words may be said with regard to the flying-phalangers (the flying-squirrels of the

colonists) of Australia, since in one respect they present a curious analogy with the flying-squirrels of the Old World. It need hardly be said that these Australian flying-phalangers are true marsupials, with a dentition resembling that of the ordinary phalangers, or, as they are locally called, opossums. The larger flying-phalangers, which constitute the genus *Petaurus*, are characterised by the full development of the parachute and the rounded bushy tail. As in the case of the Asiatic flying squirrels, we are unable to point out the non-volant type of phalanger from which they are descended.

On the other hand, the beautiful pigmy flying-phalanger (*Acrobates*), which differs from the larger forms by the scantier development of its parachute, as well as by its tail being formed after the type of a feather—that is to say, being flattened, with a line of hair along each edge—is evidently descended from the non-flying feather-tailed phalanger (*Distichurus*), or the immediate ancestor of the latter. In this case, therefore, we have an exact parallelism to the descent of the flying representatives of the scale-tails from the non-flying *Zenkerella*.

THE BEAVER IN NORWAY

HAD not the use of its hair in the manufacture of hats been superseded by that of silk, there is little doubt that the beaver, both in the Old World and in America, would by this time have been numbered among extinct animals. As it is, the creature has but a hard time of it at best, for although there is no longer a demand for its hair by the hat-manufacturer, yet beaver-fur is an article highly valued by the furrier, and equally highly esteemed by the fair sex. Although a few survive in the Rhone and the Rhine, while more numerous colonies are found in parts of Russia, the beaver has been practically swept away from most European countries, though place-names frequently bear testimony to its former presence. Among the countries where it still maintains a foothold is Norway, where Dr. Robert Collett, the well-known Zoological Professor at the University of Christiania, has described its present condition and habits.

It appears that for some years the beaver has enjoyed a certain amount of protection in Norway, and if this protection be continued, Dr. Collett is of opinion that the animal will survive well into this century. The two most important colonies now remaining are situated at Aamli and Nedrethelemarken.

The Norwegian beaver began to decrease in numbers from the early part or middle of the eighteenth century,

and by 1800 had already disappeared from most parts of the country, with the exception of the northern districts of Finmark and Nordland, and the southern province of Nedenas, or Christiansand. The work of extermination went on more or less rapidly till the year 1845, when it was somewhat checked by the enactment of protective statutes; but either these could not have worked very effectually, or the war of extermination had been only too well carried out, for in 1880 the number of individuals surviving throughout the country was estimated at only about three score. Three years later the number of head was put down roughly at a hundred, and since that date it is probable that the number has been fully maintained, if, indeed, it has not actually increased.

The statutes which have been enacted for the preservation of the beaver in Norway are not, for the most part, of a very effectual nature, and have a decidedly feudatory smack. The statute of 1845 provided that no beavers at all should be killed for ten years, and then only by the proprietors of the estates on which they were found. This was admirable so far as it went, but as from the beginning of 1856 proprietors were again allowed to kill, without either restriction as to time or number, it is obvious that the good results of the first enactment might very well have been speedily lost. Probably this was found to be the case, as in 1863 a fresh statute was propounded, establishing a close time and fixing a limitation in number. According to this statute, beavers were only allowed to be killed during the months of August, September, and October, and then only by owners of estates, who were permitted to kill but one individual annually on each separate estate.

Special exemptions might, however, be granted by the

sovereign, who was enabled to give permission for the killing of several individuals on large estates, or even to permit the proprietors to kill the whole number of animals on an island or enclosed property, thus putting some of the colonies, like the one at Aamli, entirely in the power of the owner. Moreover, although slaughter is entirely forbidden on Crown or municipal lands, beavers might be killed to any extent, and apparently in any number, on private estates where they inflicted appreciable damage.

Two much more effectual statutes have, however, come into operation: the one, dated August 31st, 1894, protecting all the beavers in the Amt of Sondre Bergenhus till the end of 1904, and the other, dated September 3rd, 1895, doing the same for the colony of Aamli till the end of 1905. The penalty for illegally killing beaver is a fine of eighty kronors (about £4 10s.), which can be inflicted on all the participators in the offence.

The chief food of the beaver in Norway consists of the fresh bark of deciduous trees, more especially the aspen, the larger branches being barked, but the twigs consumed entire, and the coarse bark of the trunk generally rejected. For winter use small branches are sunk near the entrance to the lodge, but no store of stripped bark is collected. Most of the trees felled are situated close to the water, with beaten tracks leading to them from the lodge, but occasionally some are chosen a considerable distance away from the river. The trees are gnawed all round until the portion left is so thin that the stem breaks from its own weight, the stump remaining being generally about half a yard in length, and terminating in a point like a pencil, as does the lower end of the felled stem. Small trunks or branches are, however, gnawed in a slanting

direction. Only healthy trees are selected for felling, and sometimes these are left half gnawed through without any apparent reason. No attempt appears to be made to make the trees fall in any particular direction, as they may be seen lying pointing all ways. The trunks and boughs, after being stripped of their bark, are cut into convenient lengths and employed for building, the current being used for their transport whenever practicable. Many lodges are, however, constructed in still water, and the animals are then compelled to convey the timber by their own exertions, this being effected by holding the log in the water between the fore-paws and swimming with the hind-feet.

The construction of the lodge is a serious business, occupying at least two years, and annual repairs are necessary to keep it in habitable condition. Building operations take place in the autumn, lasting from September till well into November, and as they are nearly always undertaken at night, it is but seldom that an opportunity occurs of seeing the animals at work. In Norway the lodges are either conical or elliptical in shape, the majority being now of the latter type. The conical lodges, which appear to have been more common formerly than they are at present, are placed on the banks of ponds in which the water level is constant, such ponds being either natural or made by the animals damming up the stream. On the other hand, the elliptical or elongated lodges are invariably formed on the banks of a river with running water subject to constant change of level. Although the majority are considerably smaller, they may be as much as fifty feet in length, the width seldom exceeding eight or nine feet. One half generally lies under water, and thus prevents the edifice from being left high and dry

when the river runs low. The main entrance is invariably placed at the end of the submerged portion, but another outlet may be made on shore beyond the lodge itself, and is then generally covered with a layer of twigs, or twigs and earth. As a rule, the lodges are isolated, although a couple may be built in contact. Seen from a distance, the lodge looks like a confused pile of timber and earth without any definite arrangement. The logs employed are usually from a couple of feet to a yard in length, although they may sometimes be double this size; twigs are also largely used, and sometimes take root and develop into saplings on the roofs. Stones are but seldom employed. Many of the logs are stripped of their bark, but others are built in just as they are felled; and not infrequently drift logs of pine and other trees which are men-felled are annexed. The logs and twigs are thrown together pell-mell, and the interstices tightly rammed with earth, the thickness of the walls being about a couple of feet. The passage leading from the submerged edge of the lodge to the central dwelling-chamber is usually single, and about twenty inches in diameter, its interior, when in clayey soil, becoming worn perfectly smooth.

A double lodge opened in 1895 is described by Mr. Collett as follows: "The left or short lodge contained an unoccupied chamber without lining. The right, which was long and of considerable age, extended for some way under an oak coppice. The chamber in this was situated about six yards from the water, half a yard underground, and consisted of an enlargement of the passage to about three-quarters of a yard in height." It was thickly lined with the under-bark of the aspen.

Ice-floes and floating timber do much damage to the lodges, and thus entail an annual repair, which, as already

A Colony of Beavers.

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said, is carried out in autumn. Spring and autumn floods also frequently submerge the lodges, from which large portions are loosened and swept away. From twenty to thirty years is the probable period during which a lodge is habitable.

On the bank of the river in the neighbourhood of the lodge numerous burrows are met with, a few of which are in connection with the lodge, although most are entirely separate. Burrows are the first refuges formed by the beaver when taking possession of a fresh spot, and they may accordingly be likened to the rude sheds erected by workmen employed on building a mansion. Probably each lodge is tenanted only by a single couple and their young family, the young beavers, when able to do without parental assistance, either settling down temporarily in burrows in the immediate neighbourhood, or wandering away to found new colonies. Small lodges constructed in a kind of jerry-building fashion appear to be run up by bachelor beavers who have not yet ventured to take upon themselves the responsibilities of a wife and family. There may, however, be also spinster beavers to whom such accommodation is also necessary—it is to be hoped only temporarily.

Dams are constructed where beavers have quartered themselves by the sides of gently flowing streamlets, or small ponds through which a current runs, in order to obtain water of sufficient depth and maintaining a constant level. The dam is substantially built and difficult to demolish. One examined in 1895 was constructed at the outflow of a small stream through a forest-marsh; and where there was formerly but a small shallow pool, a pond or lake of some few hundred yards in diameter soon resulted from the labours of these indefatigable rodents.

The dam, which was about fifteen feet in length, with a cross-section of some two feet, was entirely made in the course of three weeks during the summer of 1890. In Canada, when the dam is sufficiently stout, the pool will eventually silt up and form a "beaver-meadow," but Mr. Collett does not record any of these "meadows" in Norway.

During the cold winter months the beavers, although not hibernating in the proper sense of the term, pass what appears a somewhat dull existence in the central chamber of the lodge, the roof of which for most of the time is buried in snow. Sometimes, however, when the weather is mild for the season, and an unusually cold autumn has prevented the completion of the annual repairs at the proper time, the beavers will venture out from their retirement for a short period in order to remedy such dilapidations as stand in urgent need of immediate attention. When they have been engaged on such works their footprints are visible in the snow. Immediately after the breaking up of the ice in spring the animals issue forth to procure a fresh supply of food and resume their daily avocations.

The young beavers are born in April or May, three being apparently a common number in a litter. At first their eyes are closed, but they grow rapidly, and by September or October are about the size of a cat. When able to shift for themselves, they leave the parental lodge, and frequently start off to found a family in some fresh locality, although sometimes they set off on their wanderings alone. Following the courses of small streams, they frequently track straight across the open mountain-slopes for many miles, so that one or more not infrequently make their appearance in valleys where none have been

known for years. They will even occasionally cross small arms of the sea, and the perils of the journey end in death to no inconsiderable number.

Several old-time superstitions still cling round the beaver. One of the most persistent and most incorrect is that the flat scaly tail is employed as a trowel for plastering down the mud during building operations. Another is that the secretion of the tail-glands—the *castoreum* of the old pharmacopoeia—has the property of frightening away whales or porpoises when approaching the boat! Still more strange is the old idea that some individuals were compelled to lie on their backs and be laden with building materials, when they were dragged by their companions to the scene of operations. Probably this fable originated from the circumstance that many individuals have the hair worn off the back from constantly passing up and down the narrow burrow or entrance to a lodge.

THE EXTINCT QUAGGA

WHEN the Dutch first colonised that part of Africa of which Cape Town now forms the capital, they found the country absolutely swarming with a great variety of species of large game and other animals, whose form and appearance were for the most part unfamiliar. As they themselves came from a land which had long since been stripped of the larger members of its fauna, it is possible that unfamiliarity with these prototypes was one of the causes which led to the indiscriminate and often inappropriate bestowal of the names of the large mammals of Europe, or compounds of the same, on the animals of the new country. What, for instance, can be more inappropriate than the transference of the Dutch name for elk (eland) to the largest of the Cape antelopes—unless, indeed (which is scarcely likely), the settlers were acquainted with the fact that etymologically the word signifies, in its Greek original, "strength"? Neither is hartebeest (stag-ox) much better, although wildebeest (wild ox) is by no means an unsuitable designation for the animals known to the Hottentots by the title of gnu. Bastard hartebeest, on the other hand, is a cumbrous and senseless name for the antelope the Bechuanas call tsessabe, and it is much to be regretted that the Boers did not see fit to adopt for South African animals the native titles they found ready to hand.

In two instances, and apparently in two only, so far as the larger animals are concerned, they did, however, adopt this practice. The first instance is that of the large and handsome spiral-horned antelope now universally known as kudu, a name which is certainly not Dutch, and is believed by Sir Harry Johnston to be of Hottentot origin, since it is unknown to the Kaffirs or other tribes who speak dialects of the Bantu language. The second case is that of the animal forming the subject of this article, which is now universally known as quagga, from a corruption of its Hottentot name quacha, pronounced by the natives as "quaha." Even in this instance, however, the Boers appear at first to have displayed considerable reluctance to adopt the native name, for they originally called the animal wilde esel (wild ass) in the same way as they christened its cousin, Burchell's zebra, wilde paard, or wild horse. Eventually, however, better counsels prevailed, and *Equus quagga* became known to the Cape Dutch by the aforesaid native name, while the wilde paard (whose early title still survives in Paardeberg) was renamed bonte quacha, or striped quagga. When, however, the true quagga became very rare and eventually exterminated, the prefix *bonte* was dropped from the Dutch designation of Burchell's zebra, which was henceforth known throughout South Africa as the quacha, or quagga, pure and simple. Hence much confusion, and possibly also a factor in the extermination of the species to which that title of right belonged. For as the name in question continued to be in common use in South Africa at the time the true quagga was on the point of extermination, it is quite probable that this may have been the reason why the attention of naturalists in Europe was not drawn to its impending fate while there was yet time.

According to the best obtainable evidence the quagga appears to have become extinct, in Cape Colony at any rate,* about the year 1865, at which date a specimen was actually living in the London Zoological Society's menagerie; while another had died there only the year before. Of the latter example, a male, presented to the Society in 1858 by the late Sir George Grey, the carcase was fortunately acquired by the British Museum, where both its skin and skeleton are now preserved. The former specimen—a female purchased in 1851—survived till the summer of 1872, when its carcase was sold (apparently without the least idea of its priceless value) to a London taxidermist, from whom the mounted skin was acquired many years after by Mr. Walter Rothschild, for his museum at Tring. Not impossibly, this specimen was actually the last survivor of its kind, although, as already said, there was not even a suspicion that it belonged to a rare species. Most fortunately for natural history, a photograph of this animal was taken in the summer of 1870 by Messrs. York & Son, and it is from that picture that most of the later figures of the animal appear to have been taken. It is probably the only photograph of a living specimen in existence.

According to a note published by the Secretary, in the *Proceedings* for 1891, the only other example of the quagga in the London Zoological Society's menagerie was one purchased in 1831. No record of its death appears to have been preserved, but it may have been the same

* From the fact that a skin was purchased by the Edinburgh Museum in 1879, Mr. G. Renshaw (*Zoologist*, February, 1901) has suggested that the species may have survived in the Orange River Colony till about that date; but the Edinburgh specimen appears to have been an old one at the date of its purchase.

specimen of which the skin was exhibited in the Society's old museum in 1838, or thereabouts. These, however, were by no means the only specimens brought alive to England, for as early as 1815 one was in the possession of Lord Morton, while somewhat later on in the last century Mr. Sheriff Parkins was in the habit of driving two quaggas in a phaeton about London, and in narrating this circumstance the late Colonel Hamilton Smith mentions that he himself had been drawn in a gig by one of these animals, which showed "as much temper and delicacy of mouth as any domestic horse." Another quagga was in the possession of a former Prince of Wales, and there are records of others in England. The skulls of the two driven by Mr. Parkins, as well as a portrait of one of them, are preserved in the Museum of the Royal College of Surgeons.

In addition to the specimens in the British, Edinburgh, and Tring museums, several skins are preserved on the Continent. With one exception, all appear to be of the same general type as the London example photographed by Messrs. York in 1870. The exception is one in the Imperial Museum at Vienna, of which a description and photograph have recently been published by the Director, Dr. L. von Lorenz, in the *Proceedings* of the Zoological Society of London. Unfortunately there is no record as to the locality where the Vienna specimen (which is a female) was obtained, all that is known being that it was acquired by purchase in 1836.

Compared with the ordinary type of quagga, as exemplified by York's photograph, the Vienna animal is of somewhat larger dimensions, with a creamy buff (instead of greyish or chocolate-brown) ground-colour on the upper parts, with the exception of the head, which is clay-brown. A more striking

difference is to be found in the broader dark stripes (of which there seem to be more in a given space), and a corresponding decrease in the width of the intervening light intervals. The stripes also seem to extend farther back on the body.

But there is also a difference between quaggas of the type of the one photographed by York and those figured by the early writers, as exemplified by the plate in Colonel Hamilton Smith's volume on horses in the "Naturalists' Library." In the specimen there represented, which not improbably came from Cape Colony, the head, neck, and forequarters are marked by narrow black stripes on a chestnut ground. The markings are, indeed, as Dr. von Lorenz remarks, just the reverse of those of the Vienna specimen; the British Museum example and the one figured by York being in some degree intermediate between these two extreme types.

With some hesitation, Dr. von Lorenz suggests that there may have been local races of the quagga, as there are of Burchell's zebra.

Even in the days of its abundance the quagga (which, by the way, takes its name from its cry) had a comparatively limited distribution, ranging from the Cape Colony up the eastern side of Africa as far as the Vaal River, beyond which it appears to have been unknown. In this respect it closely resembled the white-tailed gnu, which, however, is known to have crossed that river in one district. Curiously enough, the two species lived in close comradeship, and in the old days their vast herds formed a striking feature in the landscape of the open plains of the Orange River Colony. Both have now disappeared from the face of the country, for the white-tailed gnu, if, indeed, any are now left, only exists in a semi-domesticated state on a few farms.

Owing to its rank flavour, and especially its yellow fat,

the flesh of the quagga was almost uneatable by Europeans, although it was keenly relished by the Hottentots, who, in the early days of the Cape Colony, were largely fed upon it by their Dutch masters. Whether this was the cause of its comparatively early disappearance from that part of the country, it is now impossible to say, but certain it is that when Sir Cornwallis Harris made his trip to the interior in 1836, quaggas were no longer to be met with in any numbers in Cape Colony, although Colonel Hamilton Smith, writing a few years later, states that they were still to be found within its limits. North of the Vaal River they occurred, however, in their original multitudes, and it was not till about the middle of the last century that the Boers took to hide-hunting, and thus in a few years accomplished the extermination of the species.

Allusion has already been made to the facility with which the quagga could be broken to harness, and it seems probable that the species could have been more easily domesticated than any of its South African relatives. Another trait in its disposition is worth brief mention. It was said to be the boldest and fiercest of the whole equine tribe, attacking and driving off both the wild dog and the spotted hyaena. On this account the Boers are stated to have frequently kept a few tame quaggas on their farms, which were turned out at night to graze with the horses in order to protect them from the attacks of beasts of prey.

Throughout the whole of the plain country to the south of the Vaal River the quagga was the sole wild representative of the horse family, the true zebra being confined to the mountains of Cape Colony and adjacent districts. North of the Vaal River the veldt was, however, dotted

over with herds of Burchell's zebra, the aforesaid bonte quagga, which, inclusive of its local races, has a very extensive geographical distribution in East and Central Africa. It is scarcely necessary to say that this species differed from the quagga in having the whole or the greater part of the body striped, as well as by the more brilliant coloration and the pattern of the striping. One very remarkable feature in connection with this species must not be passed over without notice. In the original and typical race (now nearly extinct), which was obtained just north of the Vaal River, in British Bechuanaland, and therefore immediately adjacent to the northern limits of the quagga, the whole of the legs, as well as a considerable portion of the hindquarters, are devoid of stripes. In this respect the typical form of the Transvaal species comes much nearer to the last-mentioned animal than do the races from more northern districts, in which the hindquarters and legs are more or less completely striped; the striping attaining its fullest development in the most northern race of all, the so-called Grant's zebra of Somaliland and Abyssinia.

Of course, these gradations towards the quagga type of coloration of the more southern representatives of Burchell's zebra, as well as the differences in the coloration of the quagga itself as compared with zebras, have a meaning and a reason, if only they could be discovered. And it may be remarked incidentally in this place that unless we attempt to account rationally for such variations, there is little justification for the modern practice of distinguishing between the local races of variable species.

The striping of the zebras, which there is considerable cause for regarding as the primitive type of coloration of the horse family in general, is evidently of a protective nature.

It was stated some years ago that zebras a short distance off were absolutely invisible in bright moonlight, and I have reason to believe that the same is to a great extent the case in sunlight. For some reason or other the species inhabiting the plains (not the mountains, be it observed) of South Africa have tended to discard this striped coloration, the southern race of Burchell's zebra exhibiting the first, and the quagga the second stage in this transformation. In North Africa the transformation has been carried a stage farther, the wild asses of the Red Sea littoral having discarded their stripes almost completely in favour of a uniform grey or tawny livery. In this part of the continent there is now no trace of a transitional form, whatever may have been the case in the past, and we thus have the sharp contrast between the uniformly coloured wild asses of the coast of the Red Sea on the one hand, and the fully striped zebras of Abyssinia and Southern Somaliland on the other.

Whether there is anything in the climatic and other physical conditions of the plains of Cape Colony which renders a partially striped species less conspicuous than one in which the striping is fully developed, the disappearance of the quagga makes it now impossible to determine. But observation might advantageously be directed to the comparative invisibility, or otherwise, of the wild asses of the Red Sea littoral and the fully striped zebras of the interior, and whether this would be affected in any degree by the transference of the one to the habitat of the other. Whatever be the explanation, the fact remains that at the opposite extremities of Africa some of the members of the equine tribe have developed a tendency to the replacement of a striped livery by one of a uniform and sober hue, and that in the south of the continent this tendency

exists only in the species inhabiting the plains. Moreover, it is only in South Africa that the transitional form is met with, and only in the north of the continent that the striping has been completely lost.

But, as I have already mentioned in earlier articles, this is only one phase of a general tendency among mammals to replace their spots or stripes by a uniformly coloured coat.

So far as I am aware, no one has ever attempted to give a philosophical reason for this remarkable tendency. But till an adequate explanation of the phenomenon be forthcoming, naturalists, to repeat the words of a well-known ornithologist, have left half their work (and I am inclined to think the more important half) undone. Without ascertaining the reason for phenomena of this nature, our zoological work is, indeed, as though a man were content with describing the mechanism of a complicated machine without an inkling as to its use.

One word more, and I have done. To the systematic zoologist, the quagga is an animal of special interest as affording evidence of the intimate relationship between the zebras and the wild asses. Although, judging from its geographical distribution, it was probably not the actual transitional form between the two groups, yet it serves to show the manner in which the transition was effected.

ANCIENT AND MODERN HIPPOPOTAMUSES

THE popular conception of hippopotamuses is that they are clumsily built creatures of enormous size and bulk, spending the greater part of their time in the rivers and lakes of Africa, where they are more at home than on land, diving with the readiness of a crocodile, and even walking on the river bed with their bodies submerged many feet below the surface of the water. As regards the common hippopotamus (*Hippopotamus amphibius*), which is the one that alone has been exhibited in our Zoological Gardens, this conception is a perfectly true one. As, however, is so frequently the case in popular zoology, this conception, excellent as it is so far as the common species are concerned, does not cover the whole ground, for it happens that there exists in Liberia a second species of the genus, known as the pigmy hippopotamus (*H. liberiensis*), differing not only in size, but likewise in habits, from the one with which we are all familiar. In place of a total length of about eleven feet, measured in a straight line, and weighing probably between three and four tons, the pigmy hippopotamus is not larger than a good-sized wild boar, although it has the short and stout limbs of its gigantic cousin, with which it also agrees to a certain extent in the relatively large size of its head. As regards its mode of life, this species differs, however, *in toto* from the common one. Instead of passing at least

as much of its time in the water as on land, and never living away from rivers or lakes, the pigmy hippopotamus is an inhabitant of the dense tropical forests of that part of Western Africa which is its home, where it apparently leads a life very similar to that of wild pigs, wallowing in swamps after the manner of those animals, but apparently not habitually frequenting rivers, though it is doubtless, like almost all mammals, able to swim well when the necessity arises. Moreover, in place of associating in large herds after the manner of the common species, and never moving far from one particular locality, the Liberian hippopotamus is a comparatively solitary creature, going about at most only in pairs, and wandering long distances through the woods, where it seems to have no definite place of abode. At the present day the creature appears to be very rare, and there are even rumours that it is extinct.

Out of a large number of representatives of the genus once spread widely over the Old World, the common and pigmy hippopotamuses, both of which are confined to Africa, are the only species which have survived to the present day; and the reader will at once see, when we take into consideration the probable habits of the extinct kinds, how fortunate it is that these two widely different forms have been preserved. Were there only the common species, we should have had no conception that any hippopotamus possessed the habits characterising the smaller kinds, and might thus have been led into drawing very erroneous inferences as to the mode of life and habitat of fossil species.

The general appearance of the common hippopotamus is so familiar that but little is necessary in the way of description. It may be observed, however, that the enormous size

of the head, and especially the great width of the mouth, the prominent position of the eyes and nostrils, the minute ears, bulky body, short and stout limbs, and short tail, are among the most striking external features of the creature. The presence of hoofs (four in number on each foot) shows that the hippopotamus belongs to the great order of hoofed, or ungulate, mammals, and the thickness of its nearly naked hide led the older naturalists to place it among what used to be called the pachyderms. It has been shown, however, by anatomical investigations that the group thus designated, which included such totally different forms as elephants, rhinoceroses, and hippopotamuses, is an entirely artificial one, and that the last-named animals, together with their near relatives the pigs, are much more closely connected with the ruminants.

If the reader desires to know why zoologists place such very dissimilar-looking animals as the hippopotamus and the giraffe in the same great group, while they sunder from the former the apparently more similar rhinoceroses, it may be replied that this is largely due to the difference in the structure of the feet of the two groups. In that the bones of the skeleton of the two middle toes are symmetrical to a line drawn between them, the hippopotamuses and pigs resemble the ruminants, whereas the rhinoceroses agree with horses in having the middle toe (which is alone present in the latter) symmetrical in itself. One of the essential characteristics of the ruminants is the circumstance that in the lower part of the leg the two middle toes are supported by a single bone known as the cannon-bone, which consists anatomically of two originally distinct elements welded together, while the supporting bones of the small lateral toes are incompletely developed. If, on the other hand, we examine the skeleton

of a hippopotamus, we shall find that in each foot the four nearly equal-sized toes are severally supported by four complete and distinct bones, known in the fore-limb as the metacarpals and in the hind-limb as the metatarsals; and it will be obvious that this is a much simpler or more generalised type of foot-structure than that which characterises the ruminants. If, again, we contrast the foot of a hippopotamus with that of a pig, we shall find that whereas in the latter the lateral pair of hoofs are considerably smaller than the middle pair and do not touch the ground when the animal is walking on a hard surface, in the former the two pairs are nearly equal in size and are all applied to the ground in walking. In this respect the hippopotamus is the most primitive of all the even-toed hoofed mammals that have survived to the present day, and is, therefore, a creature of special interest to the believer in evolution. It is, indeed, a member of the great group from which the ruminants are considered to have originated; although, if the reader should be led from this statement to jump to the conclusion that a hippopotamus was in any sense an ancestor of the giraffe, he would be led into a grievous error. As is the case with nearly all existing animals of a primitive type, the hippopotamus, in place of being an ancestral form, is a side branch from the original stock, which has developed certain specialised features not found in the latter. To show that this is the case, we have but to study the teeth of the various species of hippopotami, which are of such a nature as to show conclusively that those of the ruminants could not have been derived from them.

In the group of animals last mentioned the molar-teeth have crescent-shaped columns on their grinding surfaces. Extinct animals show a complete passage from such teeth

to a simple type not unlike that now found in the pigs. The molar-teeth of the hippopotamus, though of the same general plan as those of the latter, have, however, their four main columns, when partially worn, with a distinctly trefoil-shaped pattern; and it is quite evident that such a tooth could never have given rise to the crescent-teeth of the ruminants. The hippopotamus molar is, indeed, quite peculiar, and its structure is so well marked and characteristic that any person who has once seen a specimen could immediately identify any example that might come under his notice.

As regards their front teeth, it may be mentioned that hippopotamuses have an enormous pair of curved tusks or canines in each jaw. In the common species, between these huge tusks are two pairs of incisors, those of the upper jaw being of nearly equal size, whereas in the lower jaw, where these teeth are cylindrical and project nearly horizontally forwards, the central ones are very much larger than the lateral pair. If, however, we examine the lower jaw of the pigmy Liberian species, we shall find that normally there is but a single pair of incisors between the tusks, which would lead to the conclusion that this animal is a more specialised type than its larger relative. The truth of this inference is curiously confirmed by the circumstance that individuals of the Liberian hippopotamus are occasionally met with in which there are two incisor-teeth on one side, while on the other there is but the single tooth; this being an excellent example of what evolutionists term reversion or atavism. This, however, by no means brings us to the end of the variation in the number of these teeth obtaining in the group under consideration; but before proceeding farther it is necessary to remark that, since in ordinary mammals the typical or

full complement of incisor-teeth consists of three pairs, it is natural to suppose that one pair has been lost in the common species. That such is really the case is demonstrated by the extinct Siwalik hippopotamus (*H. sivalensis*) of the Pliocene deposits of the outer ranges of the Himalaya. Here between the two large tusks there are three pairs of incisor-teeth, which differ from those of the common species in being all of nearly equal size; and if we were to examine the upper jaw, we should find that in this also there is the same number of teeth. In the presence of these three pairs of incisors the Siwalik hippopotamus resembles the pig, from which it departs less widely than does the common species in that these teeth are relatively smaller and also of nearly equal size. The Siwalik hippopotamus must accordingly be regarded as a less specialised species than either of its living cousins; and since, together with an allied species from the Irrawady Valley known as the Burmese hippopotamus (*H. iravaticus*), it is the oldest representative of the genus, its generalised features are precisely what evolutionary considerations would have led us to expect.

There is, however, yet another curious point in connection with these teeth demanding a moment's notice. From the evidence of the two species mentioned, it is quite impossible to determine which of the three pairs of lower incisors found in the Siwalik hippopotamus have disappeared in the common species. Fortunately, however, palaeontology here once more comes to our aid, showing not only which pair has been lost, but how the loss was brought about. From the gravels of the Narbada Valley in Central India, which are probably intermediate in age between the Pliocene deposits yielding remains of the Siwalik hippopotamus and the brick-earths of our own

country in which occur those of the common African species, there are found two extinct members of the genus, one known as the Narbada hippopotamus (*H. namadicus*), and the other as the Indian hippopotamus (*H. palaeindicus*). In the former of these the lower incisors are similar in size and number to those of the Siwalik species; but in the latter, while the inner and outer pairs are very large, there occurs on each side between them a minute and rudimentary tooth, squeezed out from the general line to the upper margin of the jaw, and evidently just about to disappear altogether. We have thus decisive evidence that the missing pair of lower incisor-teeth in the common hippopotamus is the second; and we further see how a complete transition can be traced, as regards the number of these teeth, from the Siwalik species through the common one to the Liberian hippopotamus. While it is possible that the African hippopotamus may have been directly derived from the Siwalik species, it is quite clear that the pigmy hippopotamus is not the descendant of its giant existing cousin.

With regard to the geographical distribution of the genus, we have already said that the two living species are confined to Africa, to which it may be added that there is no record of their having ever occurred in the districts lying to the north of the Sahara during the historic period. They are, therefore, essentially inhabitants of what naturalists term the Ethiopian region, although they are quite unknown in the island of Madagascar, which belongs to the same zoological province. So far as I am aware, there is no evidence that the pigmy species ever ranged beyond its present habitat of Liberia, although the case is very different with regard to the range of the common species. At the present day this animal is found from the Cape Colony

northwards to the cataracts of the Nile, and it extends westwards to Senegal; but while for several centuries it has been very seldom met with on the Nile below the entrance of the Atbara and Blue Nile, there is abundant evidence that in the time of the Pharaohs it was common in Egypt, where in the temple of Edfu, as well as several other buildings, there are frescoes representing the mode in which it was hunted and speared. That the hippopotamus is the animal indicated in the Book of Job under the name of behemoth is, according to Canon Tristram, undoubted, but there is no evidence that the Jews were acquainted with it otherwise than during their sojourn in Egypt. It is true, indeed, that the writer just mentioned suggests that its range may have extended eastwards as far as Palestine, but this is mere conjecture, and had the creature ever lived there the expeditions which have from time to time explored that country ought to have found some of its remains. In the Pleistocene and upper Pliocene deposits of Southern and Central Europe there occur, however, numerous remains of a hippopotamus which cannot be specifically distinguished from the existing African form, although it is generally of rather larger size. The difference in size was at one time thought to indicate that the fossil form was a distinct species, but the discovery many years ago of a half-fossilised jaw in the alluvium of the Nile near Kalabshi, in Nubia, showed that in former times the African hippopotamus attained dimensions as large as the European form. In England the hippopotamus ranged at least as far north as Leeds, and it is a remarkable circumstance that in many places its remains have been found in association with those of the reindeer. How animals now inhabiting countries with such totally different climatic conditions as tropical Africa and Lapland could have lived

in the same country at the same time, is very difficult to understand. If the hippopotamus had been different from the living African one, we might have regarded it as a terrestrial species, like that of Liberia, and thus perchance capable of standing a colder climate; but being identical with the former, we are perforce compelled to believe that its habits were similar, and that in its home the rivers must have been more or less free from ice throughout the year. Whatever may be the true explanation of the difficulty, it is pretty clear that no theory of summer and winter migrations will hold good, as the hippopotamus is essentially a resident animal.

Returning once more to Africa, we may notice that in Algeria, where the genus is now unrepresented, a small species (*H. hipponensis*) flourished during the Pleistocene period; this species being distinguished by carrying three pairs of lower incisor teeth, which differed from those of other members of the genus in having their enamel smooth and their extremities somewhat expanded, thus approximating to the corresponding teeth of the pigs. Equally noteworthy is the occurrence of another species, Lemerle's hippopotamus (*H. lemerlei*), in Madagascar, where its remains are common in the great marsh of Ambulisatra. Somewhat intermediate between the common and the Siwalik species, this rather small hippopotamus had sometimes three and sometimes two pairs of lower incisors. Certain traditions current among the Malagasy suggest that this species may have lived within the historic period, and it may even be one of several mysterious animals alluded to by an early European voyager.

In addition to the common species, Southern Europe, inclusive of Cyprus, Malta, and some of the other Mediterranean islands, was the home of several smaller species,

one of which, the Cyprian *H. minutus*, had much the proportions of the Liberian species, although its molar-teeth are of a simpler type. Possibly these small forms may have been more or less completely terrestrial in their habits.

The three Indian species have been already sufficiently discussed, while mention has been likewise made of the Burmese hippopotamus. The latter species, by the way, was decidedly pig-like in many parts of its structure, and may well, therefore, have been a marsh-haunting animal. It was at one time thought that one of the later Indian hippopotamuses was an unknown animal referred to in Sanscrit literature, but further investigation has shown this view to be untenable. Eastwards of Burma, we are unaware that there is any evidence of the existence of these animals, and they appear to have been always unknown in the New World.

Although it is possible that in Madagascar Lemerle's hippopotamus may have been exterminated by human agency, such an explanation will not hold good with regard to the other fossil species. So far as can be seen, India and Burma are now in every way as well fitted to be the dwelling-places of hippopotamuses, giraffes, and ostriches as they were during the Pliocene period, when those animals either wallowed in their lakes and rivers, or stalked over their plains ; and as the former countries have not been completely swept during the interval by a glacial period, it seems impossible to divine the reason why these creatures should have so completely vanished from the one area and have survived in full strength in the other.

THE DEER OF THE PEKING PARKS

OCTOBER 12th, 1860, will always be memorable as the date of the burning of the Imperial "Summer Palace" in the Yuangming Yuan, the wonderful pleasaunce situated to the north-west of Peking. The Yuangming, which at the time had apparently been unvisited by Europeans, occupies an area of many hundred acres, and is in fact a park diversified with lakes, and containing a collection of buildings of immense extent, among which was the Summer Palace. The most beautiful part is the forest clothing the flanks of the Hiang-chan hills, which attain a height of a thousand feet, and from which may be viewed at the foot the extensive lake, and in the far distance the walls of Peking enveloped in a smoky haze. Dotted through the gardens were temples, lodges, and pagodas, groves, grottos, lakes, bridges, terraces, and artificial hills. "It certainly was," writes a spectator, "one of the most beautiful scenes I had ever beheld." In the Summer Palace were gathered together all the treasures and curiosities accumulated by the reigning dynasties of China during untold centuries. All these perished in the conflagration, which lasted two days. Whether this burning of the palace, which was ordered by Lord Elgin as a punishment for the atrocities inflicted by the Chinese on British subjects, was justifiable, it is not our province to inquire. Mr. Justin McCarthy, in his "History of Our Own Times," considers that it was.

All that concerns us here is the fact that among the loot sent home from the destruction of the Yuangming Yuan were the skins and antlers of certain deer which had been shot in the gardens. These specimens, now in the British Museum, appear to have been obtained by Colonel Saul, although Consul Swinhoe was the gentleman by whom they were sent to this country.

Although there does not appear to be any record that such was the case, these specimens may be taken as an indication that among the other attractions of the grounds of the Summer Palace were herds of deer, kept either for the purposes of sport or to enhance the beauty of the landscape. The best of the three specimens sent home was a young stag in the winter coat, of which a coloured figure was given in the *Proceedings* of the Zoological Society of London for 1861. By the late Dr. Gray, then keeper of the Zoological Department of the British Museum, this deer was regarded as belonging to an ill-defined species named many years before. Two years later this identification was disputed by Mr. Swinhoe, by whom it was regarded as representing a new species, for which the name *Cervus hortulorum*—the deer of the (Summer Palace) Gardens—was, appropriately enough, suggested.

For many years this species was regarded as inseparable from one inhabiting Manchuria, which is now known to be a very different animal. But among the deer now living in the Duke of Bedford's park at Woburn are a herd of a very beautiful species from Northern Manchuria, which is now ascertained to be identical with Mr. Swinhoe's *Cervus hortulorum*. These Peking deer (as it has now been agreed to call the species) are remarkable for the extraordinary difference between their summer and winter dress—a difference so great that persons who have

m a photograph by the Duchess of Bedford.]

A Peking Stag with the Antlers in Velvet.

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seen them at one season may well be excused for not recognising them at the other. In the summer coat, as shown in the plate, they are of a brilliant reddish chestnut, profusely spotted with white; in winter, on the other hand, when the coat of the old stags becomes very long and shaggy, they are uniformly umber-brown, although traces of spots may persist in the younger stags and hinds. The old stags are but little inferior in size to red-deer, with which species certain hinds from the Summer Palace were indeed identified by Mr. Swinhoe, who quite failed to recognise that they were really the adult form of his "garden-deer."

In England the Peking deer seems to thrive as well as red or fallow deer, and in time we may hope to see it established in many of our parks.

But the Yuangming Yuan was not the only park where deer were kept by the Chinese Emperors. To the south of Peking lies a park known as the Non Hai-tzu (or Nanhai-tze), far exceeding in extent the Yuangming Yuan, the brick wall by which it is enclosed being forty-five miles in circuit. This imperial hunting-park, as it is commonly called by Englishmen, is separated from the city by a plain, which is marshy in places, and gives rise to a river flowing in part of its course through the park itself. The whole tract is thickly forested, but villages and military posts are dotted here and there in the clearings.

The park was in former days strictly guarded, and no Europeans were allowed entrance, although there are reports that by the aid of disguises a few entered from time to time. According to rumour the park was the home of large herds of deer of various kinds, as well as of flocks of the Mongolian gazelle, or yellow sheep, as it is called by the Chinese.

Till the year 1865 naturalists had no idea as to the species of deer to be found in the Non Hai-tzu, the Anglo-French expedition of 1860 having confined their attention to Peking and the Yuangming Yuan. In February of the former year, however, the well-known French missionary, explorer, and naturalist, Père Armand David, obtained an opportunity of looking over the wall, and was much astonished at the sight which met his eyes. In addition to Mongolian gazelles, he saw herds of a species of deer which he then regarded as an unknown kind of reindeer, although he described it as somewhat donkey-like in appearance, with a long well-haired tail. At that season of the year the stags were without antlers. At this time the energetic missionary was quite unable to obtain a specimen of the new deer, but by bribing the Tatar guards of the park he succeeded, in January of the following year, in acquiring the skins of a stag and hind. Meantime the French Minister at Peking had been endeavouring to procure a living pair of this deer by diplomatic means, and in February of that year succeeded in his efforts. The stag, however, unfortunately died soon after its removal from the park, and its skin was sent to Paris with those of the two specimens obtained from the Tatar guards.

When these specimens arrived at the Paris Museum they were examined by Prof. Milne-Edwards, who in due course described them as representing a new genus and species of deer, under the name of *Elaphurus davidianus*. By the Chinese, it may be well to mention, the animal is known by the name of mi-lou, or, more commonly, sen-pou-siang.

The accompanying photograph gives an excellent idea of the external appearance of the stags of this very

From a photograph by the Duchess of Bedford.]

PÈRE DAVID'S MI-LOU DEER.

The antlers are not completely free from velvet.

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remarkable and interesting species I have [illegible] its characteristics in anything like full detail would be quite out of place in a work of the present nature, and it will suffice to allude briefly to its more salient peculiarities. The name by which the Red Deer is the species differs from most of all other Deer, but bears the closest the elk and the moose is the nearest approach in the type—that is to say, in having a [illegible] jecting brow-tine [illegible] shaft, or beam, is inclined [illegible] splits in a fork-like manner [illegible] deer, and the [illegible] species of American deer having [illegible] type, is that the [illegible] undivided tine of great [illegible] from prong to the [illegible] and has but little [illegible] bifurcation is reached. The [illegible] attracted the attention of the [illegible] of the animal is particularly well [illegible] graph. The general [illegible] becoming lighter in the [illegible] limbs, and [illegible] there is but little change in the [illegible] ing to season. The [illegible] the stags in the [illegible] is that they shed and [illegible] instead of once as in other [illegible] peculiarity has always been [illegible] whether it is the result of [illegible] to say, for the species is [illegible] Indeed, it cannot [illegible] change of antlers [illegible]

remarkable and interesting species of deer. To describe its characteristics in anything like detail would obviously be quite out of place in an article of the present nature, and it will suffice to allude to a few of its more striking peculiarities. One feature by which the stags of this species differ from those of all other Old World deer, save the elk and the roe, is that the antlers are of the forked type—that is to say, in place of having a forwardly projecting brow-tine immediately above their base, the main shaft, or beam, is undivided for a short distance, and then splits in a fork-like manner. A peculiarity of the mi-lou deer, and one whereby it differs from all the numerous species of American deer carrying antlers of the forked type, is that the hind prong of the main fork forms an undivided tine of great length directed backwards. The front prong, on the other hand, is forked at least once, and has but little forward inclination till the point of bifurcation is reached. The long donkey-like tail, which attracted the attention of the Abbé David at his first sight of the animal, is particularly well displayed in the photograph. The general colour of the coat is fawn-grey, becoming lighter on the face, rump, inner sides of the limbs, and under-parts. Unlike the majority of deer, there is but little change in the colour of the coat according to season. One very curious peculiarity displayed by the stags in the herd of mi-lou deer at Woburn Abbey is that they shed and renew their antlers twice a year, instead of once, as in other deer. Whether, however, this peculiarity has always been inherent in the species, or whether it is the result of long domestication, is impossible to say, for the species is quite unknown in a wild state. Indeed, it cannot now be ascertained whether this double change of antlers took place among the herds in the

Non Hai-tzu, or even in the specimens first brought to Europe.

The date of the introduction of these deer into the imperial hunting-park is probably very remote, seeing that, as already said, they have never been found wild in any part of Asia by Europeans. It is true that, according to Dr. S. W. Bushell, to whose account reference is again made in the sequel, a Chinese writer of the latter part of the eighteenth century mentions Kashgaria as the native country of these deer; but even if that be correct, the species may have been exterminated there centuries ago. Anyway, there is but little hope of its survival in that district at the present day.

As China became slowly opened up to European enterprise, the difficulty of obtaining specimens of the mi-lou deer gradually decreased, and in August, 1869, a male and female were received at the menagerie of the Zoological Society as a gift from Sir Rutherford Alcock. A second pair were acquired by purchase in 1883, since the death of which the species appears to have been unrepresented in the Society's collection. Meanwhile specimens were from time to time received by various menageries on the Continent; and the species has bred at the gardens of the Société d'Acclimatation at Paris and elsewhere.

The subsequent history of this interesting and remarkable species is extremely sad, no one apparently having had the least idea that it was on the point of extermination until too late. No definite statements are made by the earlier travellers as to the numbers of these deer in the Non Hai-tzu when they first came under the observation of Europeans. Writing, however, in the summer of 1898 to the Secretary of the Zoological Society, Dr. Bushell

stated that he had formerly ridden among the herds which swarmed in the imperial park, where they appear to have been reserved for the sport of the Court, and were carefully protected. Whether, in later years, less care was taken than formerly to see that the park and its surrounding wall were in good condition, the account does not state; but during or about the year 1894 the Hun-ho, which flows through the park, became flooded, and breached the wall in several places. Through the gaps thus made all the mi-lou deer escaped, and appear to have been killed and eaten by the peasantry of the surrounding districts, who were suffering at that time from famine. In his letter Dr. Bushell promised to make inquiries on his return to China if any of the deer had escaped destruction, but as nothing more has been heard from him on the subject, it may be presumed that all were slaughtered.

Assuming, then, that the mi-lou deer does not exist in a wild state in some unexplored part of Kashgaria, or other remote part of Central Asia, it seems only too evident that its sole living representatives are those preserved in European collections. By far the greater number of these are now at Woburn Abbey, where they run in the open park with the other deer. They breed freely, without an undue proportion of males among the fawns; a very hopeful sign being that some hinds purchased from Paris, where they were sterile, bred after they were transferred to their new quarters. Some time ago the herd at Woburn numbered over twenty head, and it has probably increased since that date. One point in favour of the prospects of the survival of the Woburn herd is the fact that the species has for centuries been kept in a state of semi-domestication—that is to say it has

lived in an enclosed park without, apparently, any infusion of fresh blood. It would, therefore, seem probable that it will be less likely to suffer from the effects of inbreeding than is the case with animals suddenly transferred from the wild state to captivity. Every care is, of course, taken of these valuable animals, and naturalists will watch with interest the results of the attempt to renew and preserve a decadent and almost exterminated race.

So far as I am aware, Père David's mi-lou deer is the only example of a mammalian species used neither as a food-supply nor as a beast of burden which has been preserved from extermination in a semi-domesticated state.

Readers of this article who may be desirous of seeing the mi-lou deer, will find a handsome stag, with fully developed antlers, exhibited in the Natural History branch of the British Museum, where there is also the mounted head of a female—both the gift of the Duke and Duchess of Bedford. Unfortunately, the taxidermist to whom the task of mounting the stag was confided (and taxidermists are the despair of naturalists, whose name they are prone to appropriate!) took for his model a red-deer instead of photographs like the one here reproduced. Consequently, instead of having the slouching, donkey-like carriage so essentially characteristic of the species, the Museum specimen is represented with its head elevated, after the fashion of Landseer's picture, "The Monarch of the Glen."

As already mentioned, the mi-lou deer, which is the sole representative of its kind, has no near relatives in the Old World. In spite of a certain not very important difference in the structure of the bones of the fore-foot, it appears, however, to be a not very distant cousin of the typical American deer—that is to say, the numerous species other than the elk, the wapiti, and the reindeer, which

are really Old World forms, whose entrance into America is apparently a comparatively recent event. Probably both the mi-lou and the American deer are the descendants of an extinct group, with antlers of the same general type, which flourished in Europe during the later portion of the Tertiary epoch. The greater the pity that such an ancient and remarkable type as the former should be on the point of extermination!

FOUR-HORNED SHEEP

Of late years, at any rate, the attention of British breeders of sheep and cattle has been directed to the obliteration rather than to the development of horns; these weapons of offence and defence being not only quite unnecessary to domesticated animals which are never exposed to the attacks of beasts of prey, but often being the cause of serious damage, either from the animals fighting when in the open, or goring one another when crowded together during transit by rail. Among cattle the estimation in which "polled" breeds are held at the present day, and the practical disappearance of the old longhorns, are excellent examples of this fashion; while among sheep, if we except the mountain and Dorset breeds, the majority of those bred in this country are hornless.

If, however, fashion and custom had set in the opposite direction, there is little doubt that some extraordinary developments in the form, size, or number of horns might have been witnessed in both these groups of animals. Length of horn was indeed a feature in the old-fashioned breed of British long-horned cattle, and the massiveness and size of the horns of the humped cattle of Gallaland and Abyssinia, as well as the length frequently attained by the same appendages in the trek-oxen of Cape Colony, bear testimony to the facility with which developments in this direction can be encouraged.

Horn-development among domesticated cattle, however, seems to be restricted to increase in size, with some comparatively slight degree of modification in regard to general form and curvature ; and it does not appear that any breed is known in which the horns are permanently characterised by an abnormality in structure.

Very different is the case in sheep, in which the horns seem to lend themselves with great facility to abnormal development in several directions. The typical form of horn is familiar to us in the wild sheep of Europe and Asia as well as in the old classical sculptures of Jupiter Ammon ; and this type, although much reduced in size, is fairly well retained in the modern Dorset and merino breeds. In old rams of both breeds there is, however, a tendency to produce a spiral of greater length than ever occurs in wild sheep ; and this tendency is perhaps even more noticeable in the mountain breeds of Scotland and Wales. In all the above breeds the original close and incurved horizontal spiral is, however, preserved. But in the so-called Wallachian breed of Eastern Europe the horns take the form of upwardly directed corkscrews, mimicking in fact to a certain degree those of the beautiful African kudu antelope. A single skull in the old Hunterian collection of the Royal College of Surgeons indicates the existence of a closely allied if not identical breed of sheep in Sumatra.

A far more curious modification produced by domestication is, however, displayed by the augmentation in the number of the horns ; two, three, four, or even six extra horns being sometimes noticeable. When a pair of such additional horns are developed they usually occupy the upper and fore part of the head, and are of a more slender shape and take a more upright direction than the normal

pair, which generally retain their ordinary position and form, although frequently showing a more or less pronounced lack of symmetry. When the Zoological Society possessed a farm at Kingston Hill, in the year 1829, several of these four-horned sheep were kept there; but, although llamas and alpacas, which are just as much domesticated animals, are exhibited at the present day in the Society's menagerie in the Regent's Park, four-horned and other abnormal breeds of sheep are not on show. Flocks of four-horned sheep are, however, kept in several British parks.

Bearing in mind the close affinity existing between sheep and goats, it is not a little remarkable that the additional horns developed in the four-horned breed of the former should approximate to a considerable degree both in direction and in curvature to those of the latter. This, however, must not be taken as an indication that the additional pair in the four-horned sheep represents the normal pair of the goats.

Four-horned sheep belong to at least two distinct breeds, one of which is of great antiquity. According to report this breed originally came from Iceland and the Faroe Islands, where these sheep still exist, as they also do in the Orkneys, Shetlands, Hebrides, and the Isle of Man. Occasionally, it is said, the little brown sheep of the island of Soa, in the Hebrides, develop four horns, although they are normally two-horned.

Like the Soa breed, European four-horned sheep are of very small size, and dark in colour, the fleece being not infrequently mottled with patches of brown and white. The wool, too, as in nearly or quite all the inferior breeds of sheep, is much mixed with hair, so that it is by no means of a fine quality.

From the islands of north-western Europe four-horned

sheep may be traced eastwards across the northern districts of Continental Europe and Asia into China, where they appear to be comparatively numerous. Among the flocks of the nomad Tatars, the presence of four horns is associated with an enlargement of the base of the tail, owing to the deposition in that region of a large amount of fat. Although such a difference might be produced by crossing Icelandic four-horned sheep with the two-horned fat-tailed breed, it quite possibly indicates an altogether distinct breed. Moreover, Brian Hodgson, a late Anglo-Indian naturalist, in a paper on the tame sheep and goats of the Sub-Himalayas and Tibet, published in vol. xvi. of the *Journal* of the Asiatic Society of Bengal (1847), stated that the Hunia sheep of the Himalayas, which are white with black faces, occasionally develop four or more horns. Again, Darwin, in his "Animals under Domestication," mentions that merino sheep when exported to Chili display the same tendency.

A breed of black and white sheep, originally natives of Zululand and other parts of South Africa, not unfrequently develop an additional pair of horns which are quite different in shape from those of the Icelandic breed, as indeed are both pairs in colour, which is black. A flock of this breed is kept by the Duke of Devonshire at Chatsworth.

In most, if not in all cases, the two horns on each side of the head in these sheep are perfectly distinct and separate from one another at the base ; but this does not prove that they may not in the first instance have originated by a splitting or division of the young horns of the normal pair.

In this connection it is very noteworthy that the antlers of deer are occasionally bifurcate for a portion or the whole of their length on one side of the head, although there does not seem to be an instance on record where such a feature occurs

on both sides. That such duplicated antlers are due to a splitting during early development is rendered perfectly manifest by the head of a fallow-deer figured on p. 855 of the *Proceedings* of the Zoological Society for 1896. In this instance it is the right antler which is double throughout its length ; but instead of the two divisions of this antler being complete in every detail, the front one corresponds only with the fore half of the normal complete antler, and *vice versa*. Hence the proof of bifurcation.

On the other hand, in a three-horned red-deer head in the collection of Lord Powerscourt at Enniscorthy the duplicated antlers of the right side are practically replicas of one another; both being somewhat simpler than the normal left antler. In this case there is no evidence of bifurcation, but the three-horned fallow-deer seems sufficient to demonstrate that the origin of the abnormality is the same in both instances. If this be the case, there seems no reason why additional cranial appendages developed in the four-horned breeds of sheep should not have been originally due to fission, although no trace of such original splitting can now be detected. As a matter of fact, a specimen in the British Museum actually shows the occurrence of such a splitting in the horns of a ram of this breed.

Splitting seems, indeed, to be a very common mode by which abnormalities are produced. The Museum of the Royal College of Surgeons possesses, for instance, the skull of a dog in which both the upper tusks, or canine teeth, are longitudinally split for about half their length, and there is a similar specimen in the British Museum. This splitting is clearly due to a partial fission of the crown of the tooth-gum. And it is not improbable that a similar fission, carried to a greater extent, may explain the condition obtaining in the skull of a fox killed during the winter of 1900 by the

South Oxfordshire Hounds, in which there are two complete canines on each side of the upper jaw, one behind the other, giving a most remarkable appearance to the head. As already said, the complete duplication of the upper canine may quite possibly be an extreme development of the imperfect fission noticeable in the other specimens; but, on the other hand, it may be due to the growth of a supplemental germ which exists at the root of most mammalian teeth, but, as a rule, remains dormant throughout life.

To return to our sheep. It has now to be mentioned that the development of two or more additional horns in these animals is by no means the only abnormality which not infrequently makes its appearance in connection with these appendages. There is, on the contrary, an equally marked tendency to "sport" in the opposite direction--that is to say, to the coalescence of the normal pair so as to give rise to what are practically unicorn-sheep.

These unicorn-sheep have a much more restricted habitat than their many-horned cousins, being apparently confined to a certain portion of the Himalaya or Tibet, although they are not referred to by Brian Hodgson in his paper on the tame sheep and goats of the Sub-Himalayas and Tibet, already referred to.

Three specimens of the horns of this remarkable breed of sheep are known to be preserved in England, two of them being in the British Museum (to which they were presented by Hodgson), while the third is in the Museum of the Royal College of Surgeons, as the gift of Colonel Finch in 1830. The latter is described in the Museum Catalogue in the following words: "The horns have grown parallel to each other, and are firmly united throughout their whole extent, producing the appearance of a single horn, the extremity of which has been sawed off, probably

to relieve the animal of the inconvenience of pressure upon the neck."

Precisely the same description, inclusive of the sawing off of the top of the amalgamated horns, would apply to the two skulls of this breed in the British Museum.

In the case of the many-horned breed of sheep it would seem that the redundancy in horn-development is more probably a disadvantage than a benefit to the animals in which it occurs. And if, as seems to be the case, the amalgamated horn in the unicorn-sheep tends to run into the neck of the owner so as to necessitate the amputation of the tip, the abnormality is altogether harmful; so that if it occurred in a state of nature it would probably soon disappear.

This amalgamation of the horns in the unicorn-sheep presents a curious analogy to the so-called solid-hoofed pigs, which have been known from a very early period. "From the time of Aristotle to the present time," wrote Darwin, "solid-hoofed swine have occasionally been observed in various parts of the world. Although this peculiarity is strongly inherited, it is hardly probable that all the animals with solid hoofs have descended from the same parents; it is more probable that the same peculiarity has reappeared at various times and places." The peculiarity is produced by the welding together of the middle pair of hoofs into a single large hoof.

Although we may at present be unable to explain the curious variations displayed by different organs among animals under domestication, this is surely no reason why we should refuse to study them at all.

MUSK-OXEN IN ENGLAND

SOME persons are unfortunate in their names, and the same is the case with certain animals. The ruminant popularly known as the musk-ox and scientifically as *Ovibos moschatus* is an instance of this, for although no objection can be taken to the prefix "musk," and its Latin eqivalent *moschatus*, yet the English title "ox" is in the highest degree misleading, while the technical "Ovibos," which suggests characters intermediate between the oxen and the sheep, is equally unsatisfactory. To say that the creature is an animal *sui generis* would be a truism, seeing that it is the sole existing representative of the genus *Ovibos*; and yet this expression, perhaps, best conveys the real state of the case—namely, that it is a more or less isolated member of the ruminant group, coming under the designation neither of an ox nor a sheep, nor yet being a connecting link between the two. Under these circumstances it would be much better if the name "musk-ox" could be dropped altogether, and (unless it be altogether unpronounceable) its native Greenland equivalent adopted instead. Unfortunately, however, I have hitherto been unable to ascertain by what name the creature is known to the Greenlanders.

Although now restricted to Greenland and Arctic America eastward of the Mackenzie River, the musk-ox was formerly a circumpolar animal, its remains being occasionally met

with in the interior of Alaska, more commonly in the frozen cliffs of Eschscholtz Bay, and also in the ice-bound soil of the Lena and the Yenisei valleys. Although unknown in Franz Josef Land and Spitzbergen, the musk-ox extends polewards through Parry Island and Grinnell Land into North Greenland, where its northward range is probably only limited by the limits of vegetation. South Greenland at the present day is, however, too hot for such a cold-loving beast, and Melville Bay now forms the southernmost point to which it wanders on the west coast. Consequently it would seem probable that the musk-oxen on the west coast are completely isolated from those on the eastern seaboard; the central mountain range of the interior of Greenland being apparently impassable even by such hardy animals, while a transit *vid* Cape Farewell is, as we have seen, barred by climatic conditions of an opposite nature.

In America, however, the musk-ox still ranges considerably farther south, its limits in this direction being approximately formed by the sixtieth parallel of north latitude; but it is stated that year by year its southern range is slowly contracting—possibly owing to pursuit by man. When the musk-ox ceased to be an inhabitant of the Siberian *tundra*, or why it should ever have disappeared from regions apparently so well suited to its habits as are Northern Asia and Alaska, there are no means of ascertaining. But the date of its disappearance was probably by no means remote, comparatively speaking, and it is even possible that man himself may have taken a share in its extermination. However this may be, it is beyond doubt that the musk-ox was an inhabitant of the south of England, as well as of parts of France and Germany, during or about the time of the glacial epoch; its remains occurring not uncommonly in the gravels of the English

river-valleys, such as those of the Thames and Severn, as well as in the brick-earths of Kent. It is also probable that they occur in the "forest-bed" of the Norfolk coast, which somewhat antedates the great glaciation of Britain.

This being so, it is evident that the musk-ox was a living British animal within the period during which our islands have been inhabited by man, for in many of the deposits in which its remains occur flint implements and other evidences of human presence are likewise found. Probably, indeed, the early human inhabitants of Britain not infrequently made a meal of musk-ox beef; but the disappearance of the animal from the British fauna may apparently be attributed rather to a change in climatic conditions than to pursuit by man.

From that long-distant day when the last indigenous British musk-ox departed this life no living representative of the species appears to have been brought to our islands till the autumn of 1899, when a couple of young bulls were added to the collection of the Duke of Bedford at Woburn Abbey. These were captured in August in Clavering Island, situated off the coast of East Greenland, opposite König Wilhelm Land, about latitude 74° 5′ N. When they arrived they were about the size of a rather large sheep, but by March of the following year the solitary survivor had increased considerably in size, although the horns were then only just visible above the long hairs of the sides of the forehead.

Probably most of my readers are more or less familiar with the general appearance of the adult musk-ox; but those who are not would do well to turn to its portrait as shown opposite next page, or, still better, to pay a visit to the British Museum at South Kensington, where both the mounted skin and the skeleton are exhibited. The

absence of the large flattened, fibrous, and downwardly curving yellow horns, which almost meet in the middle line of the forehead of the adult bull, renders the aspect of the head of the calf very different. In other respects, however, the calves are very like the full-grown animals in general appearance, showing the same long, straight, and rather coarse hair, the conspicuous light-coloured "saddle" on the back, the white "stockings," the woolly triangular ears, the broad and almost completely hairy muzzle, and the entire burying of the rudimentary tail in the long hair of the hindquarters. Owing, however, to the inferior length of the hair on the flanks, more of the legs is exhibited in the young than in the adult; and this enables the peculiarly heavy and massive form of the pasterns and feet to be better seen. Nothing was more curious about the calves at Woburn Abbey than their movements, which recalled those of a Polar bear more than those of an ox or a sheep, the hocks being turned outwards in an altogether peculiar and distinctive manner. If this strange gait is also characteristic of the adult, it is probably adapted for progression on glaciers and other ice-coated surfaces; firmness of foothold being secured by the presence of a considerable amount of hair on the under-surface of the foot.

But there is one respect in which the Clavering Island calves differed from the adult specimens exhibited at the time of their arrival in the British Museum, as well as from the description then given of the species. This is the presence of a large patch of white hair on the forehead, as well as of an ill-defined white streak down each side of the face, and some scattered white hairs in the middle line between the muzzle and the eyes.

As these differences have been found to be constant,

From a photograph by the Duchess of Bedford.]

YOUNG BULL MUSK-OX, WITH THE HORNS ABOUT HALF GROWN. [*To face p.* 290

the Greenland musk-ox is now regarded as representing a distinct local race.

To discuss the affinities of the musk-ox on this occasion would obviously be out of place; but my readers may probably like to be informed of some of the reasons which preclude its being classed either with the oxen or with the sheep. As regards the horns, it will suffice to say that they are quite unlike those of either of the groups in question. From the oxen the animal is broadly distinguished alike by the structure of its upper teeth and also by its hairy muzzle. But this broad and hairy muzzle, in which there is a narrow naked and granular area immediately above and between the nostrils, is equally unlike the narrow and short-haired muzzle of the sheep and goats. In the structure of its upper teeth, as well as in the presence of glands below the eyes and of only two mammae in the female, the musk-ox is, however, much more like the latter group. But these two latter features are of no great zoological importance, some sheep lacking face-glands, while one species of goat has four mammae; and they in no wise serve to prove the existence of any close relationship between musk-oxen and sheep. It may be added that the aborted tail of the musk-ox separates it very widely from the oxen, in all of which this appendage is of great relative length; but in this respect the animal comes closer to the sheep, nearly all the wild forms of which have short and stumpy tails. In the extremely late development of the horns (as attested by the survivor of the Woburn pair) the species seem to stand apart from both groups.

Judging from the photographs in an account by Dr. Nathorst of the hunting of these animals, it would seem that in East Greenland musk-oxen are commonly found in small herds of

from eight to nine or a dozen in number. Their favourite haunts seem to be the gently sloping and boulder-strewn short valleys at the foot of the cliffs. Here they can be approached without much difficulty, and killed in the open, the members of the herd standing to gaze unconcernedly at the aggressor after one or more of their number has been shot down. When separated from their mothers, the young calves are by no means difficult to capture. I have been told by a friend that during an expedition to Greenland some officers succeeded in capturing a number of these calves, which they were carrying down on their shoulders to the coast; but the captive animals squealed so loudly as to attract the attention of all the Polar bears in the neighbourhood, which thereupon started in pursuit and soon induced the unarmed captors to drop their booty!

THE WILD OX OF EUROPE

AMONG many losses attributable, directly or indirectly, to the first French Revolution appears to be one which is absolutely irretrievable, and must ever remain a source of the deepest regret to the naturalist. Up to that time there were preserved in Alsace two huge horns commonly reputed to belong to the great extinct wild ox of Europe. The one was kept in the cathedral at Strassburg, the other in the episcopal palace at the neighbouring town of Zabern, or Saverne. The former was of great length (6 ft. 6 in.), and comparatively slender, while the second (which was mounted with silver and used as a drinking-horn) was also very large and apparently stouter. Its length is not given, but its capacity was so great that it would hold four litres of wine.

The French naturalist Buffon, who saw the Strassburg specimen, believed that it was truly the horn of a wild ox, or aurochs, but this opinion is disputed by Prof. Nehring, of Berlin, who, on account of its great length and slenderness, considers that it belonged to a domesticated Hungarian bullock. This is confirmed by an ancient tradition that the horn in question was that of one of the oxen employed in carting stones for building the cathedral, and Dr. Nehring's view may accordingly be accepted.

On the other hand, the Zabern horn, whose capacity, as

already said, was four litres, may, in the opinion of the same authority, be confidently regarded as that of an aurochs. For if it be assumed that its capacity has been somewhat enlarged by shaving away the inner surface, it would seem to accord fairly well in size with large fossil specimens of the bony horn-cores of that animal. For three centuries the Zabern horn was the emblem of an association known as "the brotherhood of the horn." This society was founded in May, 1586, by Bishop John von Manderscheid, who came into possession of the horn as a hunting-trophy, or heirloom, from his ancestors. The meeting-place of the society was the castle of Hoh-Barr, near Zabern. The horn was regarded with great veneration by the members of the confraternity, to which distinguished strangers were occasionally admitted as "honorary members." Like the Strassburg ox-horn, the Zabern aurochs-horn mysteriously disappeared during or soon after the French Revolution.

With its disappearance vanished apparently the last relic of an aurochs killed within the historic period. It is true that Prof. W. B. Dawkins * has stated that a pair of aurochs-horns were borne in procession on certain occasions in the canton of Uri, Switzerland, so late as about the year 1866, but it does not appear that the practice is continued, or that the horns are still in existence.

In the Middle Ages aurochs-horns were commonly preserved—although even then as rarities—in churches and castles, where they were generally used as drinking-vessels; and it is mentioned in the "Commentaries" of Julius Caesar that even in his time such horns, mounted in silver, were employed for the same purpose. In the year 1550, Conrad Gesner mentions that an entire aurochs-skull (apparently

* *Quart. Journ. Geol Soc.*, vol. xxii. p. 393.

with the horns) was preserved in the town-hall at Worms, and another at Mayence. Probably both have long since perished.

Seeing that horns are almost unknown in a fossil state, it might well have been thought that, with the loss of the historic Zabern specimen, the last example of an aurochs-horn has disappeared for ever. By a lucky chance, a nearly perfect horn of the wild ox has, however, been recently discovered in a peat-bog in Pomerania, together with a fragment of the bony horn-core on which it was supported during life. The specimen has been described by Dr. Nehring, and proved to belong unquestionably to the aurochs, as distinct from the bison.

The mention of both aurochs and bison in the preceding sentence renders it desirable to allude to a matter which has been the cause of considerable confusion and misconception. Until within the last few years, nearly all naturalists regarded these two names as synonymous, and applied them both to the bison; or rather, in many cases dropped the latter name altogether, and miscalled the animal to which it belongs the aurochs. The same practice is largely followed by sportsmen at the present day. In old German the wild ox appears to have been called indifferently either *ur* or *auerochs*; the former name being Latinised by Caesar into *Urus*. *Auerochs*, according to the usual interpretation, signifies mountain or wild ox; but opinions differ as to whether *ur* has a similar meaning, or whether it signifies the old or primeval ox. Be this as it may, the wild ox, which may even in Caesar's time have been growing scarce, gradually became rarer and rarer during the Middle Ages, till it finally disappeared in the first half of the seventeenth century. The name, however, still remained among the peasantry of Eastern Europe, and

as there was no species to which it could possibly apply save the bison, which then still survived in Poland and elsewhere, it was transferred to that animal, of which, as already mentioned, it became the common designation. A precisely analogous instance has occurred in Eastern Russia. The bison, in place of being restricted, as now, to Lithuania and the Caucasus, was formerly much more widely distributed. When it disappeared from certain districts, its name still survived, and became transferred by the peasants to the eastern race of the red-deer, as the only large wild ungulate with which they were acquainted.

As regards the gradual extermination of the aurochs as a wild animal during the Middle Ages, much important evidence has been collected of late years by Messrs. Nehring and Schiemenz.

During the Pleistocene epoch, when the mammoth and the woolly rhinoceros inhabited the British Islands and the Continent (which were then one), the aurochs was a common animal, as is attested by the abundance of its remains in formations of that age. Some of the finest and largest skulls of this so-called *Bos primigenius* were obtained by the late Sir Antonio Brady from the brick-earths of Ilford, in Essex. Other skulls have been obtained from the peat of Perthshire, from Burwell Fen, Cambridgeshire, and from a peaty deposit at Newbury, in Berkshire. A skull from Burwell Fen, in the Woodwardian Museum at Cambridge, has a flint implement embedded in the forehead, thus showing that the animal was hunted by the prehistoric inhabitants of our islands at a time when the mammoth and rhinoceros had already disappeared.

As to the date of the extermination of the wild aurochs in Britain there is no decisive evidence, but no skulls or

other remains have hitherto been identified from deposits of Roman or later age. It is, of course, possible that it may have survived till the epoch in question, or later, in the more remote parts of the kingdom, and Prof. Dawkins has even suggested that the *tauri sylvestres* mentioned by Fitzstephen, who wrote his "Life of Beckett" in the reign of Henry II., as inhabiting the forests round London, were aboriginally wild animals. On the other hand, they may equally well bave been cattle that had run wild, and this is confirmed by Bishop Leslie, of Ross, who stated in 1598 that the *Bos sylvestris* of the Caledonian Forest was white.

On the Continent, we have the evidence of Caesar as to the co-existence of the aurochs or urus in the Hercynian, or Black, Forest with the bison and the elk. And it is related how the young German warriors of that time prepared themselves for war by hunting and killing the fierce aurochs. A remarkable confirmation of the truth of Caesar's statement as to the co-existence of the aurochs and bison on the Continent during the period of the Roman occupation is afforded by the discovery in Swabia, during the widening of a railway in 1895, of two statuettes of oxen belonging to the Roman period. They were dug up in loam at a depth of nine feet below the surface, and have been described and figured by Prof. E. Fraas.* The one, as shown by the great elevation and depth of the fore-quarters, clearly represents the bison. The other, on the contrary, is as evidently intended for the aurochs. The horns have been broken off in both specimens, but what remains of them agrees in each instance with the form they should assume. In stating that both species inhabited the Black Forest contemporaneously, it is not meant that

* "Fundberichte aus Schwaben," vol. vii. p. 37 (1899).

they were actually found in company. On the contrary, it is more probable, as pointed out by Dr. Nehring, that while the one frequented the low-lying and swampy forests, the other resorted to the higher and drier woods.

Of later chronicles than Caesar's one describing the wars of Charlemagne in the early part of the ninth century alludes to the king going to hunt bisons or aurochs (*bisontium vel urorum*) in the forests of Aix-la-Chapelle. The use of the term *vel* is a little ambiguous, but Prof. Dawkins considers that the passage indicates the occurrence of both species in the forest, while he is also of opinion that the animal slain by Charlemagne was undoubtedly an aurochs. Of special importance is the mention of both bison and aurochs (urus) in a grace used at the Abbey of St. Gall about the year 1000. Another important statement is to the effect that aurochs and elk were met with by the First Crusade when crossing Germany at the close of the eleventh century, special reference being made to the enormous size of the horns of the former animals. Again, in the "Nibelungen-Lied," of the twelfth century, Siegfried is related to have killed a bison and four aurochs near Worms.

A work by the German writer Herberstain, entitled "Moscovia," of which an Italian translation was published at Venice in 1550, affords the most important evidence of any as to the survival of the aurochs in Poland (and probably also in Hungary) during the later Middle Ages. In this work appear woodcuts—rude, it is true, but still characteristic and unmistakable—of two perfectly distinct types of European wild cattle, one being the aurochs, or ur, and the other the bison. As Herberstain had travelled frequently in Poland, it is probable that he had seen both species alive, and the drawings were most likely executed

under his own immediate supervision and direction. It has been suggested that the figure of the aurochs was taken from a domesticated ox, but Messrs. Nehring and Schiemenz have shown that this is quite a mistaken idea. Not the least important feature of the work of Herberstain is the application of the name "aurochs" to the wild ox, as distinct from the bison. The locality where aurochs survived in Herberstain's time was the forest of Jaktozowka, situated about fifty-five kilometres west-south-west of Warsaw, in the provinces of Bolemow and Sochaczew. From other evidence it appears that the last aurochs was killed in this forest in the year 1627. It is important to notice that Herberstain describes the colour of the aurochs as black, and this is confirmed by another old picture of the animal. Gesner's figure of the aurochs, or, as he calls it, "thur," given in his "History of Animals," published in 1622, was probably adapted from Herberstain's. It may be added that an ancient gold goblet depicts the hunting and taming of the wild aurochs.*

As a wild animal, then, the aurochs appears to have ceased to exist in the early part of the seventeenth century; but as a species it is still among us, for there can be no doubt the majority of the domesticated breeds of European cattle are its descendants, all diminished in point of size, and some departing more widely from the original type than others. Aurochs' calves were in all probability captured by the prehistoric inhabitants of Britain and the Continent and tamed; and from these, with perhaps an occasional blending of wild blood, are doubtless descended most of our European cattle.

Much misconception has, however, prevailed as to which breeds are the nearest to the ancestral wild stock. For

* *See* Keller, *Globus*, vol. lxxii., No. 22 (1897).

instance, in 1866, Prof. Dawkins wrote as follows: "The half-wild oxen of Chillingham Park, in Northumberland, and other places in northern and central Britain, are probably the last surviving representatives of the gigantic urus of the Pleistocene period, reduced in size and modified in every respect by their small range and their contact with men."

When this was penned, it is only fair to state, the fact that the colour of the aurochs was black does not appear to have been known to the writer; neither was it then generally recognised that the park cattle (which are always white) are semi-albinoes. Such semi-albinism is always the result of domestication, as is mentioned in Bell's "British Quadrupeds," and could not have arisen in the wild state. Moreover, the park cattle display evidence of their descent from dark-coloured breeds by the retention of red or black ears and brown or black muzzles. In the Chillingham cattle the ears are generally red, although sometimes (probably as the result of crossing) black, and the muzzle brown; while in the breed at Cadzow Park, Lanarkshire, both ears and muzzle are deep black, and there are usually flecks of black on the head and fore-quarters. It is further significant that, in the Chillingham herd at any rate, dark-coloured calves, which are weeded out by the keepers, make their appearance from time to time.

Now, it is a remarkable fact that when the black Pembroke breed of domesticated cattle tends to albinism, the ears and muzzle, and more rarely the fetlocks, remain completely black or very dark grey, although the colour elsewhere is whitish, more or less profusely flecked and blotched with pale grey. In the shape and curvature of the horns, which at first incline outwards and forwards,

and then bend somewhat upwards and inwards, this breed of cattle, which is known to be of great antiquity, resembles both the gigantic aurochs and the (by comparison) dwarfed park breeds. Moreover, in both the Pembroke and the park breeds the horns are light-coloured with black tips.

Important evidence as to the close affinity between these two breeds is furnished by Low, in his "Domesticated Animals of the British Islands." It is there stated that a breed of cattle very similar to that at Chillingham was found in Wales in the tenth century, these cattle being white with red ears. "The individuals of this race yet existing in Wales are found chiefly in the county of Pembroke, where they have been kept by some individuals perfectly pure as a part of their regular farm-stock. Until a period comparatively recent, they were relatively numerous, and persons are yet living who remember when they were driven in droves to the pasturages of the Severn and the neighbouring markets. Their whole essential characters are the same as those (of the cattle) at Chillingham and Chartley Park and elsewhere. Their horns are white, tipped with black, and extended and turned upwards in the manner distinctive of the wild breed. The inside of the ears and the muzzle are black, and their feet are black to the fetlock-joint. Their skin is unctuous and of a deep-toned yellow colour. Individuals of the race are sometimes born entirely black, and then they are not to be distinguished from the common cattle of the mountains."

It is thus evident that the white park cattle are a specialised offshoot from the ancient Pembroke black breed, which, as Low mentions in a later passage, from their soft and well-haired skins, are evidently natives of a humid

climate, such as that of the forests in which dwelt the wild aurochs. This disposes, once and for all, of a theory recently broached that the park cattle are descendants of a white sacrificial breed introduced by the Romans.

A further inference is that the Pembroke cattle are themselves the most immediate descendants of the wild aurochs (which, as we have already seen, was black) now living in the British Islands, or perhaps, indeed, anywhere else. That the park-cattle have in some cases reverted to a semi-wild state, whereas the Pembrokes are thoroughly domesticated, has nothing to do with the argument, and is merely the result of the force of circumstances.

To some persons the red ears of the Chillingham and some of the old Welsh white cattle may give rise to a doubt as to the relationship with the aurochs and Pembroke breed; but it should be borne in mind that red is the primitive coloration of all wild cattle, and that, for aught we know to the contrary, the calves, or even the cows, of the aurochs may have been of this colour, as are those of the banting, or wild ox, of Java, of which the old bulls are black. The red ears of the Chillingham breed are therefore, at most, a reversion to the colour of the ancestors of the aurochs.

From the foregoing statements it is evident that the aurochs and the Pembroke and park cattle belong to one and the same species, and since the latter do not appear specifically separable from the domesticated cattle of Scandinavia, which probably formed the type of the *Bos taurus* of Linnaeus, it is clear that the aurochs has no right to a distinct species name. Instead of *Bos primigenius*, it should be called *Bos taurus primigenius*.

THE SMALLEST WILD CATTLE

AMONG the larger mammals the species or varieties inhabiting islands are more or less markedly inferior in point of size to their nearest continental relatives. In the case of the smaller islands, like Sardinia and Corsica, the reason of such a diminution in stature is not far to seek, and it is therefore not in the least surprising to find that the Corsican red-deer is a very inferior edition of its prototype of the mainland. The buffalo of the small island of Mindoro, in the Philippines, is greatly inferior in size to the wild buffaloes of the tall grass-jungles of Assam. In the case of islands of the dimensions of Sumatra and Borneo the reason of the phenomenon is by no means apparent, especially when we find them inhabited by a man-like ape (the orang-utan) almost rivalling in bulk and stature the gorilla of Western Africa. Nevertheless, even in such areas the same feature is to a certain extent noticeable, the wild buffalo of Borneo being considerably smaller than its Indian relative. As regards its actual area, the island of Celebes occupies a kind of intermediate position, since it is much inferior in extent to either Sumatra or Borneo, although far too extensive to come under the denomination of a small island. From its peculiar shape, which recalls the form often assumed by an amoeba, it has, however, a much smaller area that could be enclosed by

a ring fence than many islands of less than half its acreage, and this may really bring it, so far as the development of animal life is concerned, into the same category as a small island.

Be this as it may, Celebes has the distinction of being the home of the smallest living representative of the wild cattle, or, indeed, of the wild cattle of any period of the earth's history, for no equally diminutive fossil member of the group appears to be known. An idea of the extremely diminutive proportions of the anoa, or sapi-utan, as the animal in question is respectively called by the inhabitants of Celebes and the Malays, may be gained when it is stated that its height at the shoulder is only about 3 ft. 3 in., whereas that of the great Indian wild ox, or gaur, is at least 6 ft. 4 in. In fact, the anoa is really not much, if at all, larger than a well-grown Southdown sheep, and scarcely exceeds in this respect the little domesticated Indian Bramini cattle.

The anoa has many of the characters of the large Indian buffalo, but its horns are relatively shorter, less curved, and more upright. In this, as well as in certain other respects, it is more like the young than the adult of the last-named species; and as young animals frequently show ancestral features which are gradually lost as maturity is approached, it would be a natural supposition that the anoa is a primitive type of buffalo. This idea receives a remarkable confirmation from the circumstance that in the later Tertiary strata of Northern India there occur skulls of anoa-like buffaloes, which, however, in correlation with the continental area where they are met with, indicate animals of considerably larger dimensions than the living Celebes animal. In fact the latter, together with the somewhat larger wild buffalo, or

From a photograph by the Duchess of Bedford.]

MALE AND FEMALE ANOA, OR DWARF BUFFALO.

The bull has unfortunately lost the greater part of his tail.

[*To face p.* 304

tamarau, of the island of Mindoro, and the aforesaid extinct Indian species, constitute an altogether peculiar and primitive group of the buffalo tribe.

In its young state and during middle life the anoa is covered with a fairly thick coat of somewhat woolly hair, which is at first yellowish brown, but eventually becomes dark brown or blackish. In common with other Asiatic buffaloes, the hair is reversed along the middle line of the neck and back as far as the haunches; that is to say the tips are directed towards the head instead of towards the tail. What may be the precise object of this reversal (which is also met with among many antelopes and deer) is not yet ascertained. Possibly it may have something to do with the manner in which the animals rub themselves against the stems or boughs of trees and bushes.

In old individuals, especially those of the male sex, the coat of hair almost completely disappears, leaving the black skin bare and shining, like that of old buffaloes in general. This condition has been attained by the bull shown in the foreground of the accompanying photograph. And here it should be remarked that this particular animal has suffered the loss of the greater portion of its tail, which somewhat alters the appearance of its hindquarters. With the usual fatality that attends the grouping of animals, it has also happened that the hind-quarters of the bull are in full view, while those of the cow are concealed. The somewhat spiteful and uncertain temper of the bull is indicated by the circumstance that it was found necessary to affix brass knobs to its horns. From the more typical buffaloes the anoa differs by the general presence of white markings. These usually take the form of a gorget on the lower part of the throat,

and of one or two spots on each side of the under-jaw, as well as patches above the lateral hoofs; but there may also be white blotches on the neck and back, and in front of the eyes, while more or less of white may appear on the muzzle and the whole of the lower portion of the limbs. The special interest attaching to these white markings is that the spots on the sides of the face as well as the gorget on the throat are also met with among certain antelopes, such as the kudu and the bush-bucks; and from this it has been inferred that the anoa is more nearly related to the antelopes than is any other member of the ox tribe. Although this may be true to a certain extent, the connection with the kudu tribe is remote.

According to the meagre accounts we at present possess of the creature in its native haunts, the anoa dwells in pairs on the elevated ground of the interior of Celebes, where it passes most of its time in thick forests in the neighbourhood of water. In associating in pairs it is quite unlike all other wild cattle, with the possible exception of the Philippine tamarau; and here again it presents a resemblance to the kudu and bushbucks, which also generally go about in pairs or small family parties.

Examples of the anoa are but rarely seen alive in England, although they do not appear very difficult to procure. The first specimen exhibited in the London Zoological Gardens was purchased in May, 1871, and a second was obtained by exchange in June, 1880. Between the latter date and 1896 (when the last complete list of the animals in the menagerie was published) not a single example of this very interesting little buffalo was obtained. At Woburn Abbey the pair represented in the accompanying photograph dwelt in a good-sized paddock

by themselves, and flourished for a considerable period. Unfortunately, however, one of the two has died since the photograph was taken.

Apart from the interest attaching to it as a primitive island type, and as being the smallest representative of the ox tribe, it cannot fairly be said that the anoa is a very attractive animal. It has nothing specially to commend it from an aesthetic point of view, being, in fact, a rather ugly and ungainly creature; and from its pugnacious disposition it is not adapted for turning out in British parks among other horned animals. Moreover, it has a decidedly delicate constitution, which alone would be sufficient to render it unfit for this kind of life.

ARMOUR-CLAD WHALES

Among the many wonderful palaeontological discoveries that have startled the scientific world during the last few years, none, perhaps, is more unexpected than the assertion that the ancestral whales were protected from attack by a bony armour analogous to that with which the armadillos of South America are covered. Scarcely less marvellous is the fact that vestiges of this ancient coat of mail are still borne by such familiar cetaceans as the porpoise and its near relative, the Japanese porpoise (*Neophocaena phocaenoides*), the latter species being distinguished by the absence of a back-fin. That creatures like the modern pelagic whales and porpoises, or even the river dolphins, could ever have been invested with a complete bony armour, is, of course, an absolute impossibility. The rigidity of such a panoply would have interfered far too much with the mobility of their supple bodies, while its weight would have impaired their buoyancy. Consequently it is necessary to assume that in even the earlier representatives of these types the armour must have been in a condition of degradation and elimination, so that we must go back to more primitive forms to find it in its full development. As every one knows nowadays, whales and dolphins trace their ancestry to land animals, and nothing is more likely than that when such ancestral creatures began to take to an amphibious life on the seashore, or at the mouth of a large river, they should

have developed a dermal armour which would serve to protect them alike from the breakers and from the attacks of sharks and other marine monsters. For the idea that the terrestrial ancestors of the cetaceans were clad in armour cannot for a moment be entertained, since the primitive mammals were not so protected, and the American armadillos afford an instance of the development *de novo* of such a bony panoply at a comparatively recent epoch.

Years ago the late Dr. H. Burmeister described a porpoise from Argentina as *Phocaena spinipinnis*, on account of its possessing a number of spiny tubercles embedded in the skin in the neighbourhood of the back-fin as well as on the fin itself. "Some small spines," he wrote, "begin in the middle of the back, at the distance of twenty-five centimetres in front of the fin, as a single line of moderate spines; but soon another line begins on each side, so that in the beginning of the fin there are already three lines of spines. These three lines are continued over the whole rounded anterior margin of the fin and are augmented on both sides by other small spines irregularly scattered, so that the whole number of lines of spines in the middle of the fin is five." In a section of the skin of the back-fin the tubercles are distinctly seen, many of them being double.

Similar tubercles were described on the back-fin of a porpoise taken in the Thames in 1865; and quite recently a row of no less than twenty-five well-developed tubercles has been detected on the front edge of the back-fin of a foetal porpoise, these tubercles being nearly white and thus showing up in a marked contrast to the dark-coloured skin. Even more distinct are the tubercles in the skin of the finless back of the Japanese porpoise, where they form several rows of polygonal plates.

In a fossil porpoise (*Delphinopsis freyeri*) from the middle Tertiary deposits of Radoboj, in Croatia, the tubercles are still more strongly developed, and form a series of regularly arranged and parallel rows in the neighbourhood of the back-fin. They clearly indicate one step from the modern porpoises in the direction of a species provided with a functional bony armour in this region of the body. Between the extinct Croatian porpoise and the much more ancient whale known as *Zeuglodon*, some parts of whose body are believed to have been protected by a bony armour as solid as that of the giant relatives of the armadillos, the intermediate links are at present unknown, although they may turn up any day. *Zeuglodon* was first discovered in the early Tertiary strata of the United States, but its remains have subsequently been found in the equivalent deposits of Egypt and elsewhere, and in early times it was probably the dominant cetacean of the world. Years ago there were discovered with the bones of the internal skeleton of this whale a number of bony plates which originally formed a dermal armour; but these plates were regarded as belonging to a species of leathery turtle and as having nothing to do with the whale.

In microscopic structure, as well as in their arrangement, these polygonal bony plates are said, however, to differ from the armour of the leathery turtle; while their structure is generally similar to the undoubted bones of *Zeuglodon* with which they are found in association. Moreover, a fragment covered on one side with armour of this type has been discovered which cannot apparently be any part of the shell of a turtle, but which may well be the back-fin of *Zeuglodon*. And as the aforesaid bony tubercles of the porpoises are always found on or near the back-fin, it has been assumed that in *Zeuglodon* the entire dorsal fin,

as well as some portion of the back, was covered with a complete tesselated armour of bony plates.

The majority of the living toothed whales (inclusive of porpoises and dolphins) are furnished with a dorsal fin, and it is therefore reasonable to suppose (apart from the evidence of the specimen just referred to) that *Zeuglodon* was similarly provided; and if this be so, that cetacean was evidently a pelagic creature. For the function of a dorsal fin is to act as a kind of keel in maintaining the balance of the body, this appendage being most developed in purely pelagic cetaceans like the killer, while in littoral or fluviatile forms such as the narwhal, the white whale, and the Japanese porpoise, it is either small or wanting. It is, further, noticeable that cetaceans with pointed muzzles (of which *Zeuglodon* is one) nearly always have a larger back-fin than those in which the muzzle is short and rounded. In the whalebone bones, among which the dorsal fin is either small or wanting, its function may be discharged by the keel on the middle of the upper jaw, or, owing to corporeal bulk, no such function is required at all.

If, then, we are right in regarding *Zeuglodon* as a pelagic cetacean, it is evident that it could not have been completely armoured, but that such armour as it retained was merely a survival from a fully armoured non-pelagic ancestor. For it is almost impossible to believe, if they were armoured at all, that the ancestral form was not invested in a complete panoply, at least on the dorsal region.

The whole argument is tersely summed up as follows by Dr. O. Abel (*Beitr. Pal. Oster.-Ung.*, vol. xiii. p. 4, 1901), to whom naturalists are indebted for these interesting researches.

In their earliest stage of development the toothed whales

were full armoured. The object of the armour was as a defence against enemies, such as sharks, such an armour being also very valuable to animals exposed to the force of a strong surf on rocky shores. As the creatures took more and more to an aquatic life, the acquisition of greater speed would be of greater value to them, and this would be accomplished by diminishing the specific gravity and friction of the body, the shortening of the extremities and the development of a caudal fin to serve as the sole instrument of locomotion.

Accordingly the armour would very soon be lost by the pelagic cetaceans in order to diminish friction and lighten the specific gravity. Only among certain types, which diverged at an early epoch from the ancestral stock and took to a fluviatile or estuarine life, did vestiges of the armour remain, while the dorsal fin remained undeveloped (*Neophocaena*). That in this form, as well as in the closely allied true porpoises (*Phocaena*), we have the most primitive type of living toothed whales, is confirmed by the nature of the dentition as well as by the circumstance that in this group alone the premaxilla is toothed. The relation of the interparietal to the parietal bones of the skull is likewise confirmatory of the antiquity of the porpoises.

It may be added that *Zeuglodon* differs from modern cetaceans by the characters of its teeth, those of the lateral series being double-rooted and having compressed and serrated crowns, distantly recalling those of the leopard-seal. Between *Zeuglodon* and the shark-toothed dolphins (*Squalodon*) the gap is very great, but still one which might readily be bridged were the missing links forthcoming; and as it is, the molars of the one type seem derivable from those of the other. In *Squalodon* the molars alone retain the double-rooted character of *Zeuglodon*, and

a transition from the former, in respect of tooth-characters, to the modern dolphins and porpoises is afforded by *Saurodelphis*, of the Argentine Pliocene, in which the roots of the teeth, although single, are elongated antero-posteriorly and thus display clear evidence of their original duality. By Dr. Abel, *Saurodelphis* is indeed regarded as occupying the middle position between *Squalodon* and the modern dolphins; the porpoises being considered to form a side branch which diverged from the main stem at an earlier date than the appearance of the genus first named.

In conclusion, it may be mentioned that modern investigations tend to connect the ancestral toothed whales with the Carnivora, and in no wise support Sir William Flower's favourite idea that these cetaceans trace their descent from early ungulates.

SLOTHS AND THEIR HAIR

ALTHOUGH the name "sloth" is not infrequently misapplied by travellers to the slow-lemurs of India and the Malay countries, or to their cousins the galagos of Africa, it should properly be restricted to certain peculiar mammals inhabiting the tropical forests of Central and South America. In addition to the simple character of their teeth, which are confined to the sides of the jaws, sloths are characterised by their short faces, rudimentary tails, shaggy coats, and hook-like claws, by means of which they hang suspended, back-downwards, from the branches of the trees among which their lives are spent. Two very distinct types of these animals are known, readily distinguished by the number of toes on the fore-limb. In the one form—the three-toed sloth—there are three claws on each foot, both in the front and the hind limbs. But in the other—the two-toed sloth—there are only two claws on each of the fore-feet.

These, however, are by no means the only differences between the two types (and I say types rather than species, because it is quite probable that each modification has more than a single specific representative). In the first place, there is a difference in the form and position of the first tooth in each jaw. In the three-toed sloth, or aï, for instance, this tooth is similar in form to those behind it, from the first of which it is separated by a

space not longer than the one between the second and third. In the two-toed form, on the other hand, the first tooth is taller than those behind, and has a bevelled instead of a flat grinding surface, while the space dividing it from the second much exceeds that between any of the others. Again, the front of the upper jaw of the two-toed sloth carries a T-shaped bone, corresponding to the premaxillae of other mammals, which is totally wanting in the other species. The front of the lower jaw of the former is also prolonged so as to form a kind of spout, of which there is no trace in the latter. In both these respects the two-toed sloth comes much nearer to the extinct ground-sloths than is the case with its three-clawed cousin.

Again, if the males of the three-toed sloth be examined, there will be seen a patch in the middle of the back where, owing to the absence of the long coarse external hair, the presence of a soft orange and brown under-fur is shown. It has been stated that this patch of under-fur is made visible by the animals rubbing their backs against boughs and wearing off the long hair, but it seems much more probable that it is a sexual character. Of this under-fur the two-toed sloth has but a very imperfect development.

Apart from its extremely coarse and brittle nature, the most striking peculiarity of the outer hair of the sloths is its more or less decidedly green tinge. To see this in perfection it is necessary to examine living animals, as it tends to fade away more or less completely in skins long exposed to the light, leaving the hair of a pale greyish brown colour.

Now green is a very rare colour among mammals, and there ought, therefore, to be some special reason for its development in the sloths. And, as a matter of fact, the

means by which this coloration is produced is one of the most marvellous phenomena in the whole animal kingdom—so marvellous, indeed, that it is at first almost impossible to believe that it is true. The object of this peculiar type of coloration is, of course, to assimilate the animal to its leafy surroundings and thus to render it as inconspicuous as possible; and when hanging in its usual position from the under-side of a bough, its long, coarse, and green-tinged hair is stated to render the sloth almost indistinguishable from the bunches of grey-green lichens among which it dwells. And if the physical means by which this green tinge in the hair of the sloths is produced be little short of marvellous, what is to be said with regard to the inducing cause of the phenomenon? But of this anon.

If a few hairs of the aï be examined under the microscope by a person familiar with the structure of hair in general, it will be found that while the central portion consists of what is technically known as cortex (and not of the medulla which forms the core of the hair of many mammals), the outer sheath is composed of an altogether peculiar structure, for which the somewhat cumbersome name of extra-cortex has been proposed. Possibly it may correspond to the thin cuticle of more ordinary hairs, possibly not; either way, it need not concern us further on this occasion. In old and worn hairs this outer sheath (as it will be more convenient to call it) becomes brittle and breaks away piecemeal, leaving the central core alone.

But in ordinary circumstances the sheath tends to form a number of transverse cracks, and in these cracks grows a primitive type of plant—namely, a one-celled alga. For the benefit of my non-botanical readers it may be well to mention here that algas (among which sea-weeds are included) form a group of flowerless plants related on the

one hand to the funguses and on the other to the lichens. The majority live in water—either salt or fresh—comparatively few deriving their nourishment from the moisture contained in the air. Some, indeed, are confined to particular descriptions of rock, and possess structures recalling roots, but even in these cases it is doubtful if they draw more than an insignificant fraction of their nutriment from the substance on which they grow.

In the moist tropical forests forming the home of the sloths the algas in the cracks of their hairs grow readily, and thus communicate to the entire coat that general green tint which, as already said, is reported to render them almost indistinguishable from the clusters of lichen among which they hang suspended.

"In thick transverse sections of the hair," writes Dr. Ridewood, who has recently investigated the structure of sloth-hair, "these algal bodies show up very clearly, since they stain deeply, and have a sharply defined circular or slightly oval outline. Unless the hair is much broken, they are confined to the outer parts of the extra-cortical layer."

Not the least curious phase of a marvellous subject is that the two-toed sloth, although the structure of its hair is very different from that of the aï, also has an alga, which belongs to a species quite distinct from the one found in the former.

In the two-toed sloth the hairs lack the outer sheath investing those of the aï, and consist chiefly of the central core or cortex; in other words, they correspond to those hairs of the latter from which the outer sheath has been shed. The surface of these hairs is distinctly furrowed with longitudinal grooves or channels, and it is in these channels that the alga distinctive of this particular species is lodged and flourishes. After stating that a solution

with this sort of explanation. It is quite clear that an alga would have been of no advantage to the sloths until they had acquired their present completely arboreal kind of life, and since there is a considerable probability that both types of these animals were independently derived from some of the smaller ground-sloths, it follows that on two separate occasions an alga has independently taken advantage of this suitable vacant situation and adapted itself to its new surroundings. This difficulty, like the one connected with sloths having flourished before they acquired a lichen-growth, may appear of little importance to those who are convinced of the all-sufficiency of natural selection, but to others it may (if well founded) seem more serious.

As we have already seen, the structure of the hair in the two types of sloth is, each in its own way, absolutely peculiar, and has therefore doubtless some special purpose. And, to put it shortly, the question consequently is whether these two types of hair structure were specially developed for the reception and growth of algas designed to aid in the protection of the animals in which they occur, or whether such development has taken place for some totally different object, and that the subsequent growth of the algas, and the additional protection thereby afforded, have been purely fortuitous. The fact that the hairs themselves assimilate the body of the sloth to a lichen-clad knot shows that their peculiar character is largely protective, and it would be a most curious coincidence had this protective resemblance been enhanced by an accidental growth of algas.

As regards the manner in which the growth of algas is maintained in the sloths from one generation to another, the only rational explanation which presents itself is that the young sloths become infected with alga-spores from

their parents. As already mentioned, in very young individuals of the two-toed sloth a large proportion of the hairs are devoid of grooves; and it would therefore seem that the young sloths do not develop a growth of alga till about the time they are old enough to leave the maternal arms and hang independently on the leafy and lichen-clad boughs of their native forests.

BLIND CAVE-ANIMALS

TRUE cave-animals—that is, those which are blind and more or less completely colourless, and spend their whole time in utter darkness—must be sharply distinguished from creatures like bats and owls, which take advantage of such situations as a temporary shelter, from which they issue forth at night to the outer world. And as most of these are more or less closely allied to animals which enjoy the full light of day, one of the first things that strikes one is why they have given up the joys of an ordinary existence, to pass what appears to us to be a miserable life in total darkness. Whatever be the true explanation of this, it is of course easy to understand why they should have lost their eyes, and also the coloration characteristic of their outer-world relatives.

A curious parallel exists between the inhabitants of caves and those creatures dwelling in the dark abysses of the ocean depths; both dwelling in situations entirely cut off from the smallest trace of daylight, and both being descended from animals living either in the air or water under the ordinary conditions. In one point, however, a remarkable difference exists between the two. Cave-animals, as already said, are content to crawl or swim in Cimmerian darkness, whereas the finny and other denizens of the depths of the ocean possess organs giving forth a brilliant phosphorescent light, and likewise other organs by which they can perceive

such light, and are thus able to see and capture their prey with ease. In the absence of such artificial light and special modes of vision, cave-animals are of course compelled to rely solely on their organs of touch, hearing, and perhaps of smell; and, to our thinking at least, their life must be far more dreary and devoid of pleasure than is that of the inhabitants of the deep sea. Possibly, however, there may be other compensating advantages unknown to us; and, in any case, they lead a life of peace unmolested by the various carnivorous tyrants of the outer world. It is, however, very noteworthy that there is one blind fish inhabiting the ocean at great depths, and that a member of the same family is also found in the caves of Cuba; and this instance seems to indicate that certain families of fishes are better suited than others for taking to a subterranean existence.

Caves or subterranean channels containing the typical blind fauna are met with in many countries, apparently invariably in limestone rocks, and mostly in those belonging to the Carboniferous epoch; the latter, from their massiveness, being especially adapted for the formation of such chambers by the action of water. Needless to say, the formation of a cavern of any size in solid limestone rock is a process involving an enormous length of time for its accomplishment, and it is therefore essential that the rock should be of very considerable geological age. Indeed, it is believed that the formation of the celebrated Mammoth Cave was commenced at a comparatively early date in the Secondary era, although it was not completed till the Pleistocene. The reader must not, however, be led to suppose that cave-animals belong to an older epoch than those of the outside world, as it is probable that many of them have not taken to their present mode of

existence before the later Pliocene or early Pleistocene period.

Caves of sufficient dimensions to have developed a special fauna of their own are met with in so many parts of the world, that it would be tedious to give a list even of those which are most generally known. Among those that have attained the widest degree of celebrity is the Mammoth Cave, situated in a hill of limestone in Edmonston County, a little to the south-west of the centre of Kentucky. This enormous cave is adorned with the most beautiful stalactitic and other deposits, which, when lit by the magnesium or the electric light, form an enchanting sight. Messrs. Packard and Putman write that "in the drier localities, where the floors are dusty and everything indicates the prolonged absence of moisture, the ceiling is covered with a white efflorescence, that displays itself in all manner of beautiful shapes. It requires no stretch of the imagination to discover among these the perfect form of many flowers. The lily-form prevails, and the ceilings of many of the chambers are covered with this beautiful stucco-work, surpassing in delicacy and purity the most beautiful workmanship of man. These are not produced by the dripping of water, and the gradual deposit of sulphate of lime upon the outer portions. The stalactite is formed in this manner; but these are neither stalactitiform nor are they produced in a similar way. The efflorescence in the drier portions of the cave cannot take place where there is much moisture. The growth of these beautiful forms is from within, and the outer extremities are produced first. They are the result of a sweating process in the limestone, that forces the delicate filaments of which they are composed through the pores upon the surface of the rock, their beautiful curved forms resulting from unequal pressure at the base,

or friction in the apertures through which they are forced."

Another well-known American example is the Wyandotte Cave, traversing the Carboniferous limestone of Crawford County in south-western Indiana. Of this cave, Prof. Cope wrote in 1872 that he was not aware whether its length had ever been accurately determined, "but the proprietors say that they have explored its galleries for twenty-two miles, and it is probable that its extent is equal to that of the Mammoth Cave. Numerous galleries which diverge from its known courses in all directions have been left unexplored." The fact that the blind cave-fish appears to occur in all the subterranean waters flowing through the great Carboniferous limestone region of the central districts of the United States, suggests that the Mammoth and Wyandotte Caves are in communication. Almost equally celebrated are certain caves in the island of Cuba, which are also traversed by subterranean streams. In Europe, perhaps the most interesting cave is that of Adelsberg in Carniola, as being, together with certain other caves in Carinthia and Dalmatia, the sole habitat of that strange creature, the olm or proteus, so graphically described many years ago by Sir Humphry Davy. Although the Carinthian and Dalmatian forms of this creature differ slightly from the Carniolan type, there can be little doubt that the subterranean waters of all the three countries are, or were at a comparatively recent date, in free communication. Several caves with the blind fauna are met with in Western Europe, some of the most notable being those in various parts of the South of France; but the only one in the British Islands is Mitchelstown Cave, near Fermoy, in Ireland, which is excavated in the Carboniferous limestone.

The animal of the highest zoological position occurring among the true cave-fauna is the aforesaid olm, which is the sole representative of the genus *Proteus*, and is allied to the ordinary salamanders and newts. The olm is a somewhat eel-like creature, measuring about eleven inches in length, and with a uniformly flesh-coloured skin, save that the branching external gills are brilliant scarlet. The limbs are very short and weak, the front pair being provided with three and the hinder with two toes, and the eyes are completely hidden. Now it is a most remarkable fact that the only other salamander referred to the same family (*Proteidae*) as the olm is a peculiar North American species with well-developed eyes, four toes to each foot, and a dark brown skin, which constitutes the genus *Necturus*. From this it may be inferred that the ancestral type of the two genera formerly inhabited the northern hemisphere, and that while its transatlantic descendant has preserved the primitive number of toes and adhered to an ordinary mode of life, the European species has become more specialised in regard to its limbs, and has taken to a completely subterranean existence. According to Sir Humphry Davy the olm only makes its appearance in the Adelsberg grotto when the waters rise to an unusual height, remaining at other periods in the streams flowing beneath its floor.

The only other vertebrate animals belonging to the true cave-fauna are fish of several species. By far the most celebrated among these is the well-known blind-fish (*Amblyopsis spelaea*), which has been taken in both the Mammoth and the Wyandotte Caves, as well as in the intervening subterranean waters. This fish is the typical representative of a small family allied to the cyprinodonts, which are themselves relatives of the carps. It is quite destitute of external eyes, and its body is completely

colourless; but its sense of hearing is extraordinarily developed. In the typical form this fish has a small pair of pelvic fins, but in some examples (which have been referred to a distinct genus under the name of *Typhlichthys*) these are wanting. The maximum length is five inches. Prof. Cope writes that if these fish "be not alarmed, they come to the surface to feed, and swim in full sight like white aquatic ghosts. They are then easily taken by hand or net, if perfect silence is observed, for they are unconscious of the presence of an enemy except through the medium of hearing. This sense is, however, evidently very acute, for at any noise they turn suddenly downward, and hide beneath stones, etc., at the bottom. They must take much of their food near the surface, as the life of the depths is apparently very sparse."

The only other genus in the family is known as *Chologaster*, and differs from the last in the retention of small external eyes, and likewise in the skin being coloured. Pelvic fins are absent, and the front of the head is provided with two horn-like appendages. These small fish were first known from three examples taken in the ditches of the South Carolina rice-fields; but another specimen was caught in a well in Lebanon County, Tennessee, in the year 1854. They appear to have taken to a partially subterranean life comparatively recently, and therefore retain their eyes and dark coloration.

Although these cave-fish are clearly allies of the cyprinodonts, there is no evidence to show that they are directly descended from any member of that family. A clear descent is, however, indicated by a very remarkable family of fishes known as the *Ophidiidae*, which are near relatives of the cod tribe. With the single exception of the cave-fish of the caves of Cuba (*Lucifuga dentata*), all the members of

the family are marine forms, some inhabiting shallow water, while others are found only at great depths. Now the Cuban blind fish, in which the eyes are totally wanting or rudimentary, is a very close ally of a marine form named *Brotula*, in which the eyes are fully developed, and has evidently been specially modified from the former for a subterranean existence. The barbels, which are present in the marine fish, are replaced in the cave form by minute tubercles. This, however, is not the only point connected with this curious family, as there are two species, belonging to as many genera (*Typhlonus* and *Aphyonus*), found at great depths in the southern oceans, which are also completely blind, and apparently have no phosphorescent organs. And it would appear from these examples that the fish of this family have some special disposition towards a life of darkness.

The only other fish that can be said to belong to the cave-fauna is a member of the great fresh-water family of cat-fishes (*Siluridae*), and has been named by Prof. Cope *Gronias nigrilabris*. This fish, which attains a length of about ten inches, is closely allied to an ordinary fresh-water American form, and occurs in the Conestoga River in Lancaster County, Pennsylvania, where it is stated to be occasionally taken by the fishermen, and is believed to issue from a subterranean stream said to traverse the limestone of that district, and to discharge into the Conestoga River. Although blind, the fish has a rudimentary eye, and is therefore in process of modification for a completely subterranean life.

To refer in detail to the invertebrate inhabitants of caves would far exceed my allotted limits, and only a few words can be said on this part of the subject. Among the most interesting are the blind cray-fish, in the ordinary form of

which (*Cambarus*) the eyes are rudimentary in the adult, but larger in the young, thus affording conclusive evidence of their descent from forms fully endowed with vision. Prof. Cope has, however, described one cray-fish from the Wyandotte Cave in which the eyes are completely wanting. Among the insects, there is a totally blind beetle (*Anophthalmus*) belonging to the family of *Carabidae*, or ground-beetles, from the American caves; while those of France and Ireland have yielded a blind and colourless spring-tail (*Lipura*). Wingless grasshoppers are abundant, but these, at least generally, can see. Centipedes and spiders are also common, one of the former from the Mammoth Cave being totally blind, while others retain their eyes. In the European species of cave-spiders (*Parrhoma*) the eyes are excessively minute, and tend to become obsolete; but it is noteworthy that these creatures belong to a genus in which the eyes are small even in the open-air kinds.

It is thus apparent that all cave-animals are descended from allied forms living in the outer world, and that in many cases they belong to families which appear specially adapted for modification to a subterranean existence.

One of the most interesting discoveries is the close alliance between creatures inhabiting caves widely remote from one another. Writing of the animals of the Mitchelstown Cave, Mr. G. H. Carpenter observes that the spring-tail "is hardly to be separated from a species found in the caves of Carniola, and the *Sinella* (another blind and bleached insect) is almost identical with one inhabiting the caves of North America; while the spider is apparently the same as a cave-dweller from the Mediterranean district of Southern France, which probably occurs in the North American caverns also. . . . Any possible geographical connection which would permit the migration of subterranean animals

between Southern Europe or Ireland, or between Ireland and North America, seems altogether out of the question within any period during which the fauna can have been specifically identical with that of the present day. The only conclusion is that from ancestors, presumably of the same genus, which took to an underground life in such widely separated localities, the similar conditions of the caves have evolved descendants so similar that when compared they cannot, or can hardly, be specifically distinguished from each other."

Should these identifications be confirmed, it will be evident that the same, or closely allied species, have originated independently in different caves, and although the author cited is of opinion that this phenomenon may only hold good with regard to cave-animals, it is possible that it may be found also to exist in the outer world, since it has been suggested that the horses (*Equus*) have originated independently in the Old and New Worlds from different ancestral stocks.

GIANT LAND-TORTOISES

In the long-past days when the plains of India were the home of the mighty sivatherium and of still more gigantic elephants and mastodons, while its rivers were tenanted by hippopotamuses and huge long-snouted gharial-like crocodiles, that country was likewise inhabited by the most gigantic land-tortoise of which we at present have any knowledge. When fragments of its fossilised shell and more or less nearly complete specimens of its limb-bones came under the notice of its original describers, it was thought, indeed, that they indicated a creature of truly colossal proportions, the length of the shell in a straight line being estimated at no less than 12 ft. 3 in. In a restoration of the shell made under the superintendence of the discoverers of the species, and still exhibited in the geological department of the Natural History Museum, the length was reduced to a little over eight feet. But even these reduced dimensions appear to be considerably in excess of the reality, and it is probable that the maximum length did not much exceed six feet. A shell of this size considerably exceeds, however, that of any modern land-tortoise, so that the Siwalik tortoise, or *Testudo atlas*, as it is scientifically called, is fully entitled to rank as the real giant of its kind.

But the Siwalik tortoise was by no means the only giant species inhabiting India during the Pliocene epoch,

as remains of other, although smaller, forms have been discovered in the same deposits. The nearest living ally of the Siwalik species appears to be *Testudo emys*, of the countries east of the Bay of Bengal, in which the shell does not much exceed a foot in length. Both kinds have the front end of the lower shell produced and notched, although the production and notching are much more pronounced in the extinct form. Both also have the horny shield immediately above the tail double, instead of (as is usually the case) single; and in both the skin of the legs contained embedded nodules of bone.

The Pliocene deposits of the South of France have also yielded remains of a giant land-tortoise (*T. perpiniana*), with a shell about four feet in length, and likewise furnished with bony nodules in the skin of the limbs. And from the caves of Malta have been obtained bones of yet another very large species (*T. robusta*), apparently allied to the recently extinct *T. inepta* of Mauritius.

Going farther afield, we find evidence of the existence, during late Tertiary times, of giant land-tortoises in North America, while some imperfect shells attest the former occurrence of another species in Patagonia. It may be, therefore, assumed that during the Pliocene, and perhaps a portion of the Miocene epoch, land-tortoises of huge size were spread over the greater portion of the warmer countries of the globe.

With, or before, the close of the Pliocene division of geological time, these great reptiles seem, however, to have utterly vanished from all the continents of the world, and to have continued to exist only in certain islands, from some of which they likewise disappeared before or during the early portion of the historic period, while others have become extinct quite recently. Whether these island giant

tortoises are the direct descendants of the species which once inhabited the nearest continents, or whether they have been independently developed from smaller forms in or near their own habitats, is a question by no means easy to answer. Neither is it any less difficult to account for the complete disappearance (apparently without human intervention) of all the continental forms. Although the Siwalik mastodons, elephants, sivatheres, giraffes, hippopotamuses, and other large mammals all died off, yet many of them left descendants (collateral or direct) in either India or Africa; and this makes it the more strange that not a single descendant of any of the Pliocene giant land-tortoises should have survived in any one of the five continents. Such, however, is the case, explain it how we may.

Since the Pliocene epoch giant tortoises have been restricted to two widely sundered groups of islands. In modern times the islands most famous for these tortoises are those of the Galapagos group, which take their title from one of the Spanish names (*galdpago*) for a tortoise, and are situated on the equator, a comparatively short distance off the western coast of South America. All the other "tortoise-islands" are in the Indian Ocean, where they lie (with the exception of the lower extremity of Madagascar) within the southern tropic, off the African coast. By far the largest of these islands is Madagascar, which has long been inhabited by man, and from which the tortoises (perhaps in consequence of his occupation) disappeared ages before the historic period, being known to us only by their sub-fossilised remains. Between the northern point of Madagascar and Africa lie the islands of the Comoro group, which had also native inhabitants of their own; and from these islands the tortoises likewise

disappeared at an early date. All the other tortoise-islands in the Indian Ocean were inhabited. They include the Aldabra group, north-west of Madagascar, where the few tortoises now remaining in the south island are under Government protection, the Mascarenhas, or Mascarene group (Réunion, or Bourbon, Mauritius, and Rodriguez), the Amirantes, and the Seychelles. None of the Mascarene species survive in their proper home, and all were thought to be extinct, although a specimen has turned up from a distant island, to which it had been carried. Much the same may be said with regard to the Seychelle tortoises, which were exterminated long ago in their proper habitat. There seems, however, to be good reason for believing that a few survivors of the species have been preserved in islands to which they had been transported in ships. This transportation of tortoises from one island to another has indeed added considerably to the difficulty of unravelling the complicated history of the group, a specimen of the South Aldabra tortoise having been carried to one of the islands of the Chagos group, to the south of the Maldives, whence it was subsequently transported to Mauritius.

The accounts left by the early voyagers show that in the Mascarene and other islands of the Indian Ocean, as well as in those of the Galapagos group, the tortoises formerly existed in enormous numbers. As regards the Galapagos islands, it is remarkable that there are no small-sized species; and the same holds good for the islands of the Indian Ocean, with the exception of Madagascar, where there is one comparatively small form (*T. radiata*). It should be added that, if we except Madagascar (where there is one moderate-sized carnivore), none of the tortoise-islands were ever the home of large and predatory mammals. This naturally suggests the idea that the

survival in these islands of the reptiles under consideration is entirely due to the absence of such mammals. But, on the other hand, it has to be borne in mind that the giant Siwalik tortoise lived in a land where large mammals—both carnivorous and herbivorous—absolutely swarmed; and the same was also the case with the other extinct continental species referred to above. Moreover, we have no evidence of the existence of large tortoises on the continents of the world at an epoch before the advent of large mammals. Still, the absence of the latter from practically all the tortoise-islands is a fact that cannot be disregarded, and must almost certainly have had a very great influence on the development of their chelonian inhabitants.

In regard to the numbers in which giant tortoises formerly existed on the islands of the Indian Ocean, very few words must suffice. Writing in 1691, the French traveller François Leguat stated that in Rodriguez the tortoises covered the ground so thickly that in places you might walk a hundred paces or more by stepping from the back of one on to that of another. In Mauritius, though apparently less abundant, they were still very numerous down to 1740; and there is ample testimony that during the seventeenth and eighteenth centuries they also swarmed on Réunion, although not a single specimen of the species indigenous to that island has been preserved. The ease with which these reptiles could be captured and carried off, and the facility with which they could be kept alive on board, coupled with the large amount of excellent meat yielded by each, rendered them a valuable food-supply to the crews of ships, and it was far from uncommon for vessels leaving Mauritius to carry off a cargo of four hundred at a time, while in 1759 one of four vessels

specially engaged in carrying tortoises from Rodriguez to Mauritius took six thousand at once. Such a drain could not but tell rapidly on the supply, and by the early part of the last century the Mascarenes were denuded of their tortoise-fauna.

The Malagasy tortoise (*Testudo grandidieri*) appears, as already said, to have been exterminated before Europeans had any knowledge of the islands, but beautifully preserved shells (wanting the horny shields) have been discovered, three of which are exhibited in the Natural History Museum. Among the Mascarene tortoises, most of which are distinguished from those of Aldabra by their long thick necks and the absence of a nuchal shield* to the shell, five or six species are known in a sub-fossil state from Mauritius. To one of these (*T. indica*) special interest attaches from the circumstance that till about 1871 all the tortoises from the islands of the Indian Ocean were referred to by that name. Of equal interest, although from a totally different point of view, is the Rodriguez tortoise (*T. vosmaeri*), on account of the extreme tenuity of its bony shell—a feature shared by certain of the Galapagos species, and indicative that the thick shell characteristic of tortoises generally is not required by the island forms which have no enemies.

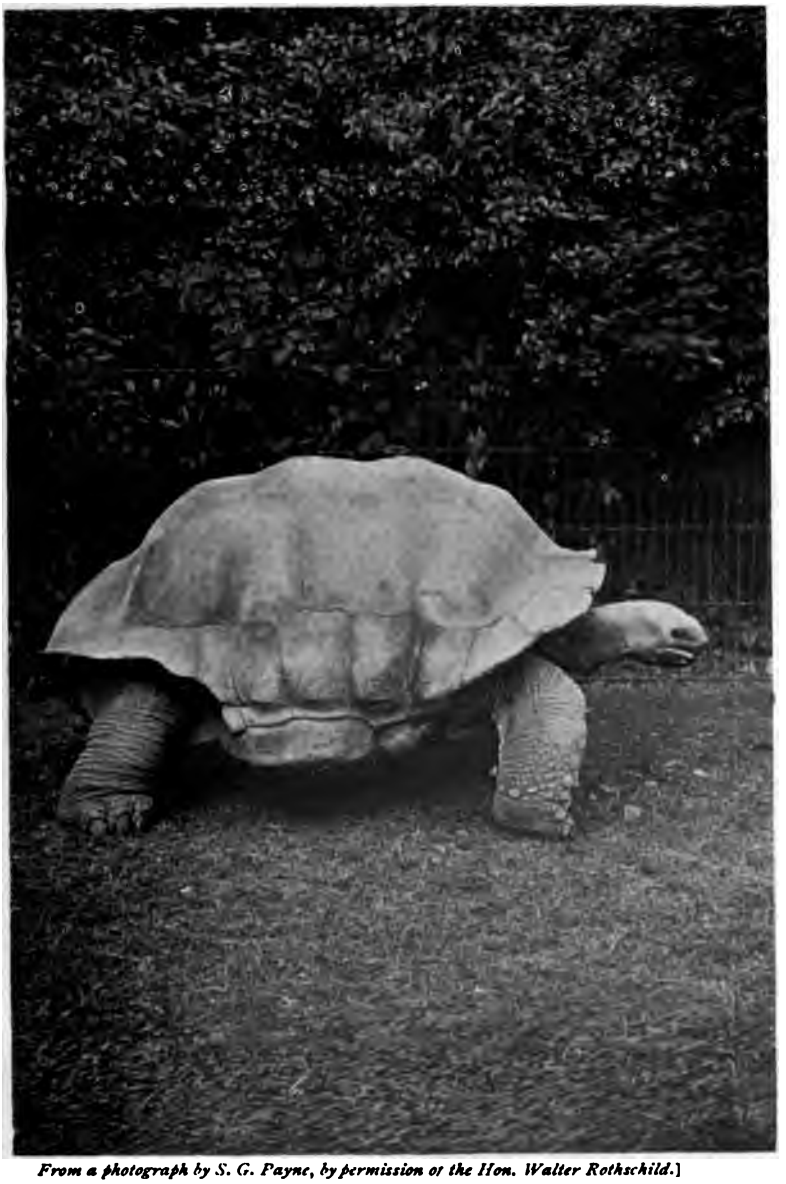
A tortoise received in company with two others from the Seychelles in 1894 by Mr. Rothschild, and now living at Tring, is believed to be one of the Mascarene species, with which it agrees in the characters referred to above. It may have come from one of the smaller islands, and thus be different from any of the named forms, although it is difficult to determine this during its life. Very little

* The nuchal shield is the single symmetrical horny plate found in the middle line of the front margin of the shell of most tortoises.

appears to be known of the Réunion, Comoro, and Amirante tortoises, but it is stated by Mr. Rothschild that the one from Réunion differed from all the other Mascarene forms, and resembled those from Aldabra. Special interest attaches to the history of the surviving representatives of the presumed Seychelle tortoise, which has been named *T. sumeirei*. It appears that in the year 1766 five giant tortoises from the Seychelles were taken to Mauritius by the Chevalier Marion de Fresne, and have been since known as Marion's tortoises. In 1833 one, which died soon after, was brought to the London Zoological Gardens, where a second arrived some years later. A third was received in 1898, but did not long survive its journey. The other two are still living in Mauritius. By far the most celebrated of these latter is the one in the Royal Artillery Barracks at Port Louis. It is now nearly blind, although otherwise in good health. The shell measures about forty inches in a straight line, and is reported to have been of that size so long ago as 1810. Probably this tortoise was at least a century old when first brought to Mauritius nearly one hundred and forty years ago. In its long thick neck, and the absence of a nuchal shield, *Testudo sumeirei* agrees with the Mascarene species, and as it is quite different from the Aldabra forms, Mr. Rothschild considers that its original home was the Seychelles, whence Marion brought his specimens—probably some of the last survivors of their kind—to Mauritius as curiosities. Possibly the tortoise brought in 1798 from the Seychelles to Colombo, where it survived till 1897, may have been of the same species. The length of its shell is fifty-three and a half inches, or only an inch and a half less than that of the great South Aldabra tortoise noticed below.

Passing on to the Aldabra tortoises, distinguished by their short necks and the presence of a nuchal shield, we have first to notice that the only member of the group surviving in a wild state in its native habitat is the South Aldabra *Testudo daudini*. Very remarkable is the history of a male of this species received by Mr. Rothschild in 1897, which is the largest known example of modern giant tortoises, the length of the carapace in a straight line being no less than fifty-five inches, or only nineteen inches short of the length assigned to that of the extinct *T. atlas*. This monster, whose original home was South Aldabra, lived for many years on Egmont Island, in the Chagos group, whence it was taken by its owner, M. L. Antelme, to Mauritius, and thence sent to England. It is currently reported to have lived in Egmont for a century and a half, but since the Chagos group was only colonised from Mauritius in the early part of the last century, there is some doubt as to the correctness of the statement. Anyway, this tortoise must have been of a prodigious age at the time of its death. During its sojourn on Egmont Island this tortoise used to bury itself and become dormant for half the year—a most remarkable fact in a tropical island. South Aldabra is a coral island very difficult to traverse, so that it is no easy matter to obtain a sight of the tortoises. Seven were, however, captured and exported in 1895, of which six reached Europe alive.

The second species of Aldabra tortoise (*T. gigantea*) formerly inhabited the north and central islands in great abundance, but is now known solely by individuals introduced by the planters into the Seychelles, where they are kept in a state of semi-domestication, and by a single specimen in St. Helena. There appear to be two races of this species—namely, the typical form, in which the shell



From a photograph by S. G. Payne, by permission of the Hon. Walter Rothschild.]

THE GIANT TORTOISE OF SOUTH ALDABRA ISLAND.

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is depressed, with the horny shields nearly smooth, and *T. gigantea elephantina*, in which the shell is highly convex, with the shields on the back marked by conspicuous concentric striations. In some instances the shield immediately above the tail is divided, as in the extinct Siwalik tortoise. The shell of a male of this species received by Mr. Rothschild in 1893 measured forty and a quarter inches in length (in a straight line) four years later. The St. Helena example is said to have lived in that island for more than a century. It is not a little remarkable that the survivors of the North Aldabra tortoise should have been preserved in the Seychelles, while those of the species believed to be indigenous to the latter islands have been kept in captivity in Mauritius.

In 1894 Mr. Rothschild's specimen of the North Aldabra tortoise weighed 327 lb., but by 1897 its weight had increased to 358 lb. These weights are, however, vastly exceeded by that of the great South Aldabra tortoise, which scaled no less than 560 lb.; this was, however, immediately after its journey to England, during which it had become much emaciated, so that these figures afford no real criterion of its proper weight. Of the habits of the North Aldabra tortoise at Tring, its owner wrote as follows: "Whenever the temperature is over sixty (60° Fahr.), this tortoise has a fine run of 350 acres of grass park, but on the temperature falling to sixty, it is kept in a shed, and when once the temperature shows permanently below 58° Fahr., it is put in an orchid-house —*i.e.*, from September to June. When at liberty in the park it lives entirely on grass, but in the hothouse feeds on carrots, cabbages, lettuce, and several other vegetables. It is very fond of rotten fruit."

Of the habits of the giant tortoises of the islands of

the Indian Ocean in a state of nature we know practically nothing, owing to the fact that in South Aldabra alone are any members of the group living in a wild condition, and that accurate observation is there practically impossible. Of the mode of life of the Galapagos species we have comparatively full accounts; but limitations of space render it impossible on the present occasion to refer further to these species, either as regards their distinctive characteristics or their history and habits. I have only to add that readers of this volume are indebted to Mr. Rothschild for the loan of the photograph illustrating this article.

SOME STRANGE NURSING HABITS

WHILE the instinct of taking care of their progeny, whether these are born in the living stage or first come into the world in the form of eggs, is more or less deeply implanted in the higher vertebrates, among the lower members of that great group the eggs and young are very frequently left to shift for themselves. Still this state of things is by no means universally the case; and I shall show in the course of the present article that certain amphibians and fishes exhibit structural modifications for the purpose of protecting their eggs and young, which are almost or quite unparalleled elsewhere. Celebrated as they mostly are on account of their highly developed parental instincts, birds exhibit no instances where the body of either parent is specially modified for the purpose of carrying about either the young or the eggs after their extrusion. And I believe that the same holds good with regard to reptiles, although into the disputed question whether vipers afford protection to their young by allowing them to run down their throats I am not going to enter here, beyond confessing that I am inclined to trust the numerous observers who state that they have seen the phenomenon with their own eyes. With certain groups of mammals—notably the marsupials—the case is, however, different, many of them, like the kangaroos, carrying their imperfectly developed young in

a special pouch borne on the body of the female until sufficiently advanced to take care of themselves. In the females of certain other members of the same order—namely, some of the American opossums—the young are carried on the parental back, with their own tails tightly twisted round that of their mother. In another group, the female spiny ant-eater, or echidna, carries about her egg in a pouch developed in the breeding season on the under-surface of her body. Most bats carry their helpless offspring tightly clinging to their breasts, and the females of many lemurs bear them clinging transversely across the under-surface of the lower part of their bodies. There is, however, one bat—namely, the naked *Chiromeles torquata*—in which both sexes are provided with a pouch on the chest. In this pouch the female carries her offspring; and it is thought probable that when there are two, the male may assist his partner by relieving her of one. Among mammals, such instances are rare, but among amphibians there are numerous instances where the eggs or young are carried about, either attached to the skin or borne in special receptacles.

Commencing with that group of amphibians represented by the frogs and toads, we find among these various instances of abnormal ways of protecting their young during the early stages of development, one of which has been known for nearly a couple of centuries, while many of the others have but recently been described. So far back as the year 1705, Fräulein Sibylla von Merian, in a work on the reptiles of Surinam, described a remarkable toad-like creature, in which the young are carried in a series of cells in the thick skin of the back of the female, which at this period has a honeycomb-like appearance. Till a few years ago, when a living example was received by the London Zoological Society, the Surinam toad (*Pipa*

americana), as the animal in question is called, was, I believe, only known in Europe by means of specimens preserved in spirit; and we have, therefore, been obliged to depend upon foreign observers for an account of its marvellous life-history. As it differs from other members of its order with regard to its method of bringing up its family, so the Surinam toad is structurally more or less unlike all its kindred, constituting not only a genus, but likewise a family group by itself. Externally it is characterised by its short and triangular head, which is furnished with a large flap of skin at each corner of the mouth, and has very minute eyes. The four front toes are quite free, and terminate in expanded star-like tips; but a large web unites the whole five toes of the hind-foot. In any state the creature is by no means a beauty, but when the female is carrying her nursery about with her she is absolutely repulsive in appearance. It would seem that soon after the eggs are laid, they are taken up by the male and pressed, one by one, into the cells in the thickened skin of his partner's back; there they grow till they fit closely to the hexagonal form of their prisons, each of which is closed above by a kind of trap-door. After a period of some eighty-two days, the eggs reach their full development and produce, not tadpoles, but actually perfect little toads. The reason of this is that tadpoles, which require to breathe the air dissolved in water by means of their external gills, could not exist in the cells, and, consequently, this stage of the development is passed through very rapidly within the egg. When ready to come forth, the young toads, which are usually from sixty to seventy in number, although there may sometimes be over a hundred, burst open the lids of their cells, and, after stretching forth their heads or a limb, make their *début*

in the world. Doubtless glad to be free from her charge, the mother-toad thereupon rubs off what remains of the cells against any convenient stone or plant-stem, and comes out in all the glory of a brand-new skin, only, before long, to undergo the whole process over again.

The Surinam toad is, however, by no means the only South American representative of its order whose nursery arrangements are peculiar, a considerable number of frogs and toads from the warmer regions of the New World having ideas of their own as to the proper method of bringing up a young family. Among these are certain species nearly allied to the familiar tree-frogs of Europe, but differing in that the females have a large pouch for the reception of the eggs. Unlike the kangaroos and other mammalian marsupials, in which the female has her nursing-pouch on the under-side of the body, these marsupial frogs (*Nototrema*) have this receptacle placed on the back, at the hinder end of which it forms a half-open tunnel, with its aperture directed backwards, although the pouch extends beneath the skin of the whole of the upper surface of the body. In this capacious nursery are deposited some fifteen or sixteen large eggs, which in due course develop into complete little frogs, without living tadpoles being produced, although at a certain stage the large eyes and long tail of a veritable tadpole are visible through the clear covering of the egg.

According to a communication made by Dr. Goeldi, of Rio de Janeiro, to the Zoological Society, the tree-frogs of the genus *Hyla* inhabiting that part of Brazil show considerable diversity in regard to nursing habits, although none of them have any part of their own body modified into a nursery. One species, for instance, builds nests of mud on the shallow borders of pools, wherein the eggs

and tadpoles are protected from enemies; while another kind lays its eggs in a slimy mass attached to withered banana-leaves, the young remaining in this nest until they have passed through the tadpole stage. In a third species, on the other hand, the larval stages are hurried through before hatching, the female carrying a load of eggs on her back, where they remain until developed into perfect frogs. Some years ago a female of this species was exhibited alive at a meeting of the Zoological Society thus loaded.

It will be observed that in all the foregoing instances the female parent takes charge of the eggs, either on or in her own body, or in a specially prepared nest, as soon as they are laid; but there are two genera of South American frogs in which it appears that, while the eggs are left to themselves, the tadpoles are carried about by their mother. The members of the one genus (*Dendrobates*) are tree-frogs from Surinam and Brazil, while the other species is from Venezuela, and belongs to the genus *Phyllobates*. Here the tadpoles, which may be from a dozen to eighteen in number, affix themselves to the body of their mother by their sucking mouths, and are thus carried about. In the case of one species of the genus first named, it appears that this mode of locomotion is only resorted to when the water is drying up and the mother desires to convey her offspring to other pools; but in the other forms the attachment seems to be more enduring.

The female of Darwin's frog (*Rhinoderma darwini*), from Chili, has, however, "gone one better" than all her allies, for not only does she get her eggs and young safely carried about until they are fit to take care of themselves, but she has actually shifted the onerous task of taking care of

them to her consort. Whereas there is nothing remarkable about the structure of the female of this frog, the male has a capacious pouch underlying the whole of the lower surface of the body, which communicates with the exterior by means of a pair of apertures opening into the mouth on each side of the tongue. As soon as his partner has deposited her eggs, the male frog takes them in his front paws and transfers them to his mouth, whence they pass into the great nursing-pouch, where they remain in perfect security till hatched into young frogs, which make their way into the world by the same passage.

Peculiar as is this method of taking care of the eggs, it is by no means altogether without a parallel in the animal kingdom, although we have to go to the class of fishes to find anything approaching a similar example. Among the so-called cat-fishes (*Siluridae*), the males of several species of the large tropical genus *Arius* take the eggs into their mouth, whence they are transferred to the capacious pharynx, where they remain until hatched. It is also said that among the fresh-water fishes of the chromid family, the males of the typical genus inhabiting the Sea of Galilee take charge of the eggs in a similar manner. Indeed, among the comparatively few fishes that take any care at all of their ova, the charge almost invariably falls to the share of the long-suffering male, whose partner, having laid the eggs, appears to think that she has done quite enough in family matters, and is at full liberty to enjoy herself as she pleases.

Of the two definitely known instances in which female fish take care of their eggs, one occurs among the aforesaid family of the cat-fishes, in the genus *Aspredo*, represented by some half-dozen species from the Guianas. In these fish, none of which exceed a foot and a half in length, the

large eggs are carried on the under-surface of the body of the female, where they form a shield-like mass extending from a short distance behind the mouth on to the pelvic fins. In some respects the position of the ova recalls a female fresh-water cray-fish in the breeding season; but a closer resemblance exists between the fish in question and the Surinam toad already described, although in one case the female bears her load upon her back, and in the other upon her abdomen. In both instances the eggs are, however, pressed into the soft spongy skin, the female cat-fish effecting this operation by lying closely upon the newly deposited spawn. Instead of being completely buried in closed cells, the eggs of the fish remain partly exposed, and are thus carried about till they are hatched; the rugosities then disappear from the skin of the abdomen of the parent, which resumes its normal smoothness.

Everybody who has been in the habit of partaking of whitebait will probably have occasionally observed among the contents of his plate a long, slender, bony fish, with a pipe-like nose, which has evidently no claim to kindred with its neighbours. This fish is a young representative of the pipe-fishes, which, together with the so-called sea-horses, so well known for their habit of curling their tails round the stems of seaweed, constitute a family especially remarkable for the variety and curious nature of their nursery arrangements. Among these an Oriental genus of small pipe-fishes (*Solenostoma*) agrees with the fish last mentioned in that the female takes charge of the eggs. For this purpose she is provided on the lower surface of her body with a roomy pouch, formed by the coalescence of the pelvic fins with the skin of the abdomen. The inner walls of this pouch are furnished with long filaments, which aid in keeping the egg in position; and it is highly

probable that after the young fish are hatched they are retained for some time by attachment to the walls of the chamber. In the true pipe-fishes (*Syngnathus*), on the other hand, the task of looking after the nursery falls to the males, which are provided with a long pouch on the under-surface of the tail, formed by a fold of skin arising on each side, and the two meeting in the middle line. How the eggs are conveyed into this pouch I am totally unaware, but when once there, they are completely enclosed by the junction of the edges of the two folds of skin, and thus remain till they are hatched into minute eel-like pipe-fish, which soon make their way into the world by thrusting open the folds of the pouch. In the sea-horses the development is carried one stage farther, the nursing-pouch being completely closed along the middle line, and only communicating with the exterior by means of a small aperture at the anterior end, through which the eggs are by some means or other introduced, and by which in due course the young make their escape. Certain pipe-fishes (*Doryichthys*) differ from the ordinary forms in that the males have the pouch situated beneath the abdomen instead of under the tail; and it is not a little remarkable that in certain allied genera (*Nerophis*, etc.) the eggs are simply attached to the lower surface of the abdomen of the male without the development of a pouch. We have thus an excellent instance of the evolution of a special organ, so far as the abdominal pouch is concerned; but it would seem highly probable that the caudal pouch of the allied forms must have been independently evolved, in which event we should have a remarkable example of parallelism in development.

Although many fishes retain their eggs within their bodies until the young are hatched and attain a consider-

able size, I am not aware that any others have special arrangements for carrying about their eggs after extrusion, with the exception of the aberrant lung-fish (*Protopterus*) of tropical Africa. In this genus the numerous eggs and embryos are reported to be nursed in a long gelatinous pouch attached to the sides of the back of one of the parents, although which of the two is charged with this office does not appear to be ascertained. Several kinds of fish are, however, in the habit of constructing nests for the reception of their eggs, while a few take advantage of other animals for their protection. For instance, the females of the small roach-like fishes of which the continental bitterling (*Rhodeus amarus*) is the only European example, have the oviduct periodically prolonged into a tube of considerable length, by means of which the eggs are introduced within the shells of living fresh-water bivalve molluscs, where they remain secure from foes until hatched. Among the nest-building species the most familiar are the bullheads (*Cottus*), sticklebacks (*Gastrosteus*), and lump-suckers (*Cyclopterus*), in all of which, as in the other instances, the nest is formed and guarded by the male fish. In the sea-stickleback the nest is a large structure composed of pendent seaweeds, tightly bound together into a pear-shaped mass by means of a silk-like thread. When the eggs are safely deposited within its interior, the male fish immediately mounts guard, and has been known to continue uninterruptedly at his post for upwards of three weeks. Should any damage happen to the nest, so that the precious eggs lie open to the attack of any predaceous wanderer, the janitor forthwith sets to work with the greatest energy to repair the damage, poking his nose into the structure, and rearranging the materials till all is made right. Nests are also made by the fresh-water species, and

guarded with the same care; the male not unfrequently stirring up the eggs with his snout, and often keeping up a fan-like movement of his fins for the apparent purpose of ensuring a continual change of the water.

As nest-building fishes are comparatively rare, much interest attached to an account in the *American Naturalist*, by Messrs. Young & Cole, of the manner in which the brook-lamprey (*Lampetra wilderi*) makes a structure of this nature. It is believed that the males precede the females at spawning time and commence nest-building before the arrival of the latter. The nest is made among pebbles, but it does not seem that the lampreys follow any definite plan in its construction. They affix themselves to such pebbles as require removing from the nest, and then endeavour to swim straight away with them. In the case of a heavy stone two lampreys may join forces. The number of fish in a nest may vary from one to thirty or forty; but there are generally between three and twenty-five.

Even when no nest is built, the males of some fishes mount guard over the eggs; this being the case with the bow-fin (*Amia calva*), so abundant in the lakes of North America.

Such are some of the chief instances among amphibians and fishes where special arrangements—either of structure or of habit—are made for the protection of the eggs and young; and although these bear but a small proportion to the cases where the latter are left to themselves, yet they are sufficient to show that in these respects these two groups present peculiarities almost or quite unknown among other vertebrates. Why such special arrangements have been evolved in these cases, or whether the groups in which they occur have any advantage in the struggle for existence over their fellows, are questions which, for the present at least, must remain unanswered

THE COLOURS OF COWRIES

Among all the treasures of the shell-cabinet few are more generally attractive than the cowries, or kauris (*Cypraea*), which form the type of a family by themselves. Rivalling the olives in the brilliancy of their polished enamel, they exceed those shells in the beauty and diversity of their coloration, while their form in the adult state is so peculiar as to attract the attention of even the most unobservant. Possibly the very fact that many of them are so common as, like the tiger and Surinam-toad cowry, to be employed as decorative objects for our chimney-pieces, has, to a certain extent, detracted in popular estimation from their many striking peculiarities. But even if this be so, a moment's comparison with any other shell will at once show how different they really are. And if rarity be an additional attraction, some among the couple of hundred or so of living species are worthy of attention, even from this not very elevated standpoint. Take, for instance, the prince cowry (*C. princeps*) and the spotted cowry (*C. guttata*), examples of which have sold respectively for forty and forty-two pounds; while the beautiful orange cowry, used as a head ornament by the chiefs of the Friendly Islands, formerly fetched about twenty pounds, although good specimens can now be bought at from three to five pounds. Other species claim attention on account of their commercial uses, the ring cowry being employed by

the islanders of Eastern Asia for personal adornment, for weighting their fishing nets, and as a means of exchange; while in the latter respect the well-known money cowry has a still more extensive use over a large part of Asia.

But it is from the peculiarities of their structure and coloration that these beautiful shells claim our attention in the present article. Taking any common species, it will be seen that the upper surface of the shell approaches more or less to an egg-shape, with a notch at each extremity forming the terminations of the mouth below. Somewhat to the right of the middle line in most species runs a straight or slightly sinuous line over which the pattern of the rest of the upper surface does not extend, this line marking in the living animal the limits of the right and left lobes of the so-called mantle, which during activity extends upwards from the foot on which the creature crawls to develop the rest of the shell. Compared with an olive, in which the spire is relatively small, the shell of an adult cowry differs by the rudimentary condition or even absence of a spire; while on the under-surface the narrow mouth of the shell (not, be it understood, of the animal) is remarkable for the series of vertical ridges, or "teeth," with which its edges are armed.

Now, since almost all other univalve shells related, even remotely, to the cowries, have a more or less elongated spire at the hinder or upper end, the inquirer naturally seeks to find out the reason for the disappearance of this part in the members of the present group. In a fully adult specimen of the common black-spotted tiger cowry no trace at all of the spire can be detected, but in the equally common Surinam-toad cowry a more or less distinct remnant, partly buried in the abundant cement, is observable even in the adult. In Scott's cowry the spire is much

more pronounced, and in a half-grown specimen of the same species is so elongated as to project considerably beyond the hinder extremity of the shell. Moreover, in immature examples of this species the hinder extremity of the right margin of the shell is expanded into a wing-like extension, recalling the wing-shells, or *Strombidae*. In both the adult and the young of Scott's cowry the coloration is very similar; but in the young of the Surinam-toad cowry there is a difference both in form and in colour from the adult. In form the shell has a distinct spire, and a thin outer lip; and in still younger examples these characters are more exaggerated, the mouth being entirely devoid of teeth, and the outer lip quite thin and sharp. Again, whereas the upper surface of the adult shell has a broad dark brown margin, and the central area spotted with light brown on a ground of dark brown, the young exhibits dark and light transverse bands, with a certain amount of mottling.

Young cowries, then, are much more like ordinary shells than are the adults, and clearly indicate that the latter belong to a highly modified or specialised type. The alteration is produced by the expansion of the mantle-lobes of the adult, which deposit a shining enamel over the entire shell, eventually concealing more or less completely the spire, and thus totally modifying the original form. A young cowry is, indeed, much more like an olive or a melon-shell; but, as a matter of fact, neither of the two latter are the nearest relatives of the *Cypraeidae*, among which are the *Strombidae*, or wing-shells. And in this connection the near resemblance of the young of Scott's cowry to a wing-shell is decidedly worthy of note, as suggestive of a direct affinity between the wing-shells and the cowries.

Turning now to the interesting problem of coloration, the first feature that must strike the observer is that the pattern developed on the shells of most cowries is not seen by the animals themselves, for the reason that by the time the creature is fully protruded from its shell, the upper surface of the latter is more or less completely concealed by the fleshy lobes of the mantle. Accordingly, it would seem to be apparent that the colouring of these molluscs is developed for the purpose of protection, and not for the admiration of the different individuals or sexes of the same species. It might, indeed, be urged that as the lobes of the mantle are coloured similarly to the shell, or even more intensely, the colours are visible to the animals, and are therefore designed for mutual admiration. But had this been the object, it would surely have sufficed to restrict the coloration to the outer surface of the mantle-lobes, and not to have extended it on to their inner surfaces, from which it is deposited on the shell. As regards the utility of the cowry type of coloration for protective purposes, I have never had the opportunity of seeing the living molluscs in their native haunts, nor have I come across any description from those who have. Cowries, which are mostly tropical or sub-tropical molluscs, are, however, described as living in shallow water not far from the shore, and feeding on zoophytes; and so far as one can judge, their colours ought to harmonise well with the hues of the denizens of a coral-bank, or a mass of sea-anemones, many of which are more or less similarly spotted. If this explanation prove to be the true one, we can readily see why both the shells and the hard parts of cowries partake of the same striking types of coloration.

Turning now to the consideration of the various types of

coloration met with among cowries, it has been shown in an earlier article that among mammals spots and stripes are frequently met with in the young which disappear in the adult. Many species of deer and swine, for instance, which are spotted or striped with white in youth become more or less completely uniform in mature age; while the lion and the puma frequently exhibit traces of dark spotting in the cub stage. In these animals, therefore, it is evident that a spotted or striped coat is the original type, and a uniform tint the more advanced form. In cowries, on the other hand, it seems that transverse dark banding was the original type of coloration, and that from such banded type two later modifications have taken place. In the one of these, spotting of various kinds has resulted, while in the other a more or less uniform colour has been the final result. The primitive banded type serves to connect the cowries with less specialised shells, a young Surinam-toad cowry being strikingly like a melon-shell, both in form and colouring, while the faint banding observable in young specimens of Scott's cowry recalls the colours of many of the wing-shells, to which, as already mentioned, the former approximates in form.

The proof that banding was the original type of cowry coloration is easy, seeing that it prevails in the young of the great majority of species. In its young condition, for instance, the Surinam-toad cowry is striped, while in the adult, as already said, it has chestnut spots on a dark ground in the central area of the upper surface. Take, again, the adult and immature conditions of the common lynx cowry, the former of which is variously spotted, while the latter still retains distinct transverse dark and light bands. Still more striking is the difference between the immature and adult conditions of the lesser false Argus

cowry; the latter exhibiting small white spots on a dark ground, while the former is banded with dark and light, without the slightest trace of spotting. It may be mentioned that this species of cowry is of a long narrow shape, and it would seem, for two reasons, probable that that is the primitive form of cowries, the short and broad shape being a later modification. One of the reasons in favour of this view is that almost all cowries which retain the primitive banding in the adult condition are of the long form. Among such may be mentioned the little wasp cowry, the mole cowry (*C. talpa*), remarkable for its tawny back and dark brown base, and one variety of the carnelian cowry (*C. carneola*), as well as the orange-tipped cowry (*C. isabella*). Again, in the true Argus cowry, which develops peculiar ringed spots in the adult condition, the primitive bands are still more or less distinctly traceable at all ages.

To exemplify the second reason for the same view, we may take the serpent's-head cowry. Here we see the short round type in its full development, the coloration being chocolate-brown above and below, with the central area of the back finely spotted with white. If, however, we take a young individual of this species, it will be noticed that the shape of the shell is comparatively long and narrow, while the colouring is in the form of bands. Many other instances might be cited, but the foregoing are sufficient for my present purpose.

I may accordingly pass on to notice briefly some of the more striking types of coloration presented by adult cowries. Banded cowries have been already mentioned, but it may be added that, from the intensity of the colours, the wasp cowry is not improbably the culmination of this type. On the other hand, in the flesh-coloured carnelian cowry,

of which there is both a long and a short form, the bands tend to become very indistinct; and it may be suggested that the short form is not far removed from the ancestral type of the beautiful orange cowry, which is one of the few uniformly coloured species; such uniformly coloured forms indicating, as already said, one line of specialisation.

Among the spotted cowries several types are noticeable. Firstly, we have species in which the back of the shell is simply spotted with black or brown, among them being the tiger cowry (*C. tigris*), the panther cowry (*C. pantherina*), and the much smaller lynx cowry (*C. lynx*). As all these have a comparatively short and wide shell, they indicate an advanced type. Next we have white-spotted cowries, such as the false Argus (*C. cervus*), the lesser false Argus, and the fallow-deer cowry; and as the two former are long-shaped, while the latter is comparatively short, they seem to indicate a medium stage of evolution.

From the black- and brown-spotted forms seem to have originated the group represented by the map and nutmeg cowries (*C. mappa* and *arabica*), in which the spots are retained along the margins of the back of the shell, the central area of which is more or less finely reticulated or vermiculated, the map cowry taking its name from the width and sinuosity of the line between the mantle-lobes. In the typical nutmeg cowry the reticulations are very nutmeg-like, but in other specimens more or less distinct pale spots are dotted all over the central area, till in the variety *histrio* the spots are the dominant feature, being only separated by these lines so as to form a kind of network, or honeycomb arrangement. Perhaps the cullender cowry may be regarded as an offshoot of this type.

But another modification may apparently also be traced to the *arabica-mappa* stock, the members of which are inter-

mediate between the long and the short types. As already said, these cowries have the central area of the back reticulated or white-spotted, and lighter than the black-spotted margin. And from such a type the transition is easy to the modification presented by the serpent's-head cowry and the Surinam-toad cowry, in which the central area is white or chestnut-spotted, while the margin and much of the under-surface is dark brown. The great width and shortness of these cowries afford further evidence of their high degree of modification. Obviously the chestnut-bordered cowry is another member of this group in which chestnut spots have been superadded to the normal white-spotted central area. Apparently a special development of this type may be recognised in the white ring-cowry (*C. annulus*), the yellow ring from which it takes its name marking the line of division between the original spotted central area and the dark area. Finally, from the ring-cowry may easily be derived the money cowry, in which the ring has all but disappeared, while the marginal area has developed a series of rugosities, apparently connected with the filaments on the margins of the mantle-lobes, which scarcely intrude on the central area. Whether these two white species have a habitat different from that of their brethren is a subject well worth the investigation of those who have the opportunity.

Omitting mention of certain other sub-types, this part of the subject may be concluded by brief reference to the true Argus cowry (*C. argus*), which, from its elongated form and the retention of barring, is evidently an ancient type specially distinguished by the ring-like form of the spots.

All the above-mentioned species (together with a host of others) are members of the typical genus *Cypraea*, distinguished by the smooth and shining enamel, and the circumstance that the teeth of the mouth do not extend across

the whole of the lower surface. There are, however, other cowries differing from these by the development of rugosities on the back, and the extension of the teeth of the mouth right across the lower surface. Both these features may safely be regarded as indications of greater specialisation than exists among any of the typical cowries. One type is represented by the pustuled cowry, in which the ornamentation on the upper surface takes the form of small spherical pustules, frequently of a bright red colour, when they recall a fragment of wood overgrown with funguses. In the second, a still more advanced modification, the ornamentation of the back assumes the form of transverse ridges, which in some species are comparatively wide apart, and separated by a considerable interval in the middle line, whereas in others, like the little European cowry *Trivia europaea*), they are so closely approximated, and so nearly meet in the middle line, as to give the idea of a small and neatly parted head of hair.

Even these by no means exhaust the modifications which the cowry type is capable of assuming, as witness the pure white "poached egg" and the "weaver's shuttle," both members of the genus *Ovula*, the latter remarkable for the elongation of the two extremities of the mouth into tube-like processes. Both these, as well as certain other allied types, depart from the ordinary cowry type by their white or pinkish colour, and are therefore evidently specialised modifications. In the case of the weaver's shuttle the colour is probably produced to harmonise with the sea-fans, upon which these molluscs are 'parasitic; but further information in regard to the reason for the absence of colour is requisite in the case of the other kinds.

One result of this brief dissertation on cowries is to show how short-sighted was the idea prevalent some years ago that

shells were of no importance in the study of molluscs, and that attention must be restricted to the soft parts (the so-called "animal") alone. A wider grasp of the subject shows that nothing in Nature is unworthy of our best attention, and is sure to yield results of interest if only we approach the subject with unbiassed and unprejudiced minds.

BREEDING HABITS OF FROGS AND TOADS

Few phenomena in animated nature are more marvellous than the development of ordinary frogs and toads, in the course of which a creature to all intents and purposes a vegetable-feeding fish becomes transformed into a carnivorous reptile. In all the ordinary frogs and toads of Europe, Asia, and North America, the process of development may, very briefly, be described as follows: The eggs, which are enveloped in a glutinous matrix, are deposited in large masses in water, and in due course develop into the familiar tadpoles. At first the new-born tadpole affixes itself to some convenient object by means of a sucker, but in the course of a few days takes to a free-swimming mode of existence. In its earliest days it breathes by means of external gills, but these are soon replaced by internal gills, covered by a gill-flap, and these again by lungs. While these changes are going on, the hind-limbs, and afterwards the fore-legs, bud forth from the body, the long tail is absorbed, the larval mouth is replaced by the permanent one, and the coiled intestine is shortened and straightened. And thus in due course the aquatic, gill-breathing, limbless, long-tailed, herbivorous tadpole blossoms forth as the terrestrial, lung-breathing, four-limbed, tailless, and carnivorous frog or toad, as the case may be.

If this state of things were common to all the members of the group, it would be, as it is, sufficiently marvellous

to excite our unbounded wonder and admiration. But in many frogs and toads the course of development is modified in various ways from this typical plan in accordance with the special needs of their existence, thus giving rise to many wholly unexpected phenomena and peculiarities.

The first peculiarity is displayed by the Japanese frog (*Rhacophorus schlegeli*), in which the eggs are laid in the muddy banks of paddy-fields or ponds above the water-level. The egg-mass is kneaded into a froth by the legs of the female parent, and its exterior hardens into a kind of crust. Within this "pudding" the tadpoles are hatched; and eventually the mass breaks up into a fluid, and bursts its crust to flow into the water, carrying with it the tadpoles. If the eggs be removed from the "pudding" and transferred to water, they immediately perish.

In a West African frog (*Chiromantis guineensis*), as well as in a Brazilian species (*Phyllomedusa iheringi*), the eggs, on the other hand, are deposited in nests formed of leaves glued together by the parent. And in both instances the tadpoles swim about within a frothy substance. In the case of the latter species the nest has an opening below through which the tadpoles are eventually discharged into the water over which it is built; but those of the first species are believed to be washed off the leaves by rain, falling into water below.

The female of the little Paraguay tree-frog (*Phyllomedusa hypochondrialis*) carries her partner on her back until a suitable leaf in the neighbourhood of water is found, when the two parents bend back its tip in such a manner as to form a funnel, in which the female deposits her spawn. Two nests of this description, each containing about one hundred eggs, may be formed by each pair of frogs. After an interval of six days the tadpoles hatch out and

escape into water; if they fail to fall directly into the latter, they are capable of wriggling during a shower a distance of several inches along the ground, aiding themselves by a jumping motion. In the case of the tree-frog of Rio de Janeiro (*Hyla nebulosa*) the spawn is deposited in the sheath of withered banana leaves far away from water; the tadpoles undergoing the whole of their development in the frothy egg-mass, and actually dying if they are put into water. Here, then, we have an instance in which the normal conditions of tadpole development are totally changed.

But this is by no means a solitary example. The tadpoles of another Brazilian frog (*Cystignathus fragilis*), and probably also those of a Ceylon species (*Rhacophorus eques*), are stated to undergo a portion of their development on land. The eggs have been found in frothy masses on land, those of the former species usually in grass near pools, and its tadpoles have been observed under decaying tree-trunks. Again, a third Brazilian frog (*Cystignathus mystaceus*) never goes near water, even to spawn; the eggs being deposited in comparatively small numbers in a hole under stones or decaying wood near the edge of a pool, but above the water-level. The frothy substance in which they are hatched probably serves the tadpoles as food, since it diminishes in quantity as they develop. In a dry season the tadpoles often remain in the nest until they are of large size, but more generally they are swept into the pool when its level rises after rain above the normal. Masses of a green frothy spawn of about the size of a rook's egg found adhering to the walls of cisterns, to faces of rock overhanging water, and to moist tree-trunks in Ceylon, are believed to be deposited by the frog known as *Polypedates maculatus*. In Brazil the tadpoles of

a tree-frog (*Hyla abbreviata*) have been observed adhering to rocks by means of the flat surface of the abdomen, which acts as a sucker. Nothing is, however, known with regard to the eggs.

In all the foregoing instances the peculiarities of development are confined to the situations in which the spawn is deposited and the tadpoles are developed. There is, however, another and far more remarkable class of cases in which the bodies of either the male or female parent are specially modified to act as receptacles for the eggs and tadpoles. The best instance of this class is that of the well-known Surinam toad (*Pipa americana*),* in which the eggs are evenly distributed, as they are laid, over the back of the female by the male. Around these the skin of the back speedily thickens until each egg is enclosed in a separate cell, furnished with a lid. The eggs hatch in about eighty-two days, and the young are stated to find safety and nourishment on the parental back until their transformation is completed. The limbs make their appearance at an unusually early age, even before the external gills are shed.

Equally remarkable are the "nursery" arrangements of the pouched frogs (*Nototrema*) of South America. In these frogs the back of the female is furnished with a long tube-like pouch, having its opening at the posterior end. In this pouch the eggs, which are about fifteen in number, are deposited and hatched; and the tadpoles also undergo the whole of their metamorphosis in the same chamber. In some cases, at least, the pouch splits longitudinally

* The breeding habits of this and some of the following forms have been already referred to in a previous article; but, in order to render the present one complete in itself, it has not been considered advisable to eliminate such repetition as may exist.

when the young frogs are ready to make their appearance in the world.

Perhaps, however, the most peculiar kind of "nursery" is the one found in Darwin's frog (*Rhinoderma darwini*). In this extraordinary creature the males are provided in the breeding season with an enormous pouch on the throat, in which the large eggs (generally about ten in number) are hatched and the tadpoles protected until they become true frogs. The tadpoles never have external gills, and probably not internal ones either, so that they are much more advanced at birth than is the case with their brethren of ordinary species.

Another instance of abbreviated or accelerated development is furnished by Goeldi's tree-frog (*Hyla goeldii*) of Brazil. Here the score or so of eggs are carried on the back of the female, in which the skin of the margins is raised so as to form a kind of saucer. According to one authority, the newly hatched young are in the form of perfect frogs, which prefer not to stay in water. Another method of carrying the eggs is displayed by a Cingalese frog (*Rhacophorus reticulatus*), in which they adhere to the abdomen of the female.

Some frogs, again, such as *Spea hammondi* of North America, are in the habit of depositing their spawn in rain-pools liable to rapid desiccation. And in these cases the tadpoles acquire limbs at an unusually early age, in order to be enabled to seek a fresh pool when their own shows signs of giving out. The tadpoles of an Idaho frog (*Spea bombifrons*) show a singular dislike to water, even while in the swimming stage of existence; they breathe air, and live on the bare ground in smooth spaces which they clear for themselves. Three other American species (two of which belong to the genus *Dendrobates*,

and the third to *Phyllobates*), to which water is essential while in the tadpole stage, adopt the plan of carrying their young attached to their backs (either by means of suckers or of a viscid secretion), and are thus enabled to transport them to another pool when occasion arises. In the case of the genus last mentioned, it is the father frog on whom the burden of carting about his family falls, but in the other instance it is not known to which sex this duty is entrusted. A frog (*Arthrolepis seychellensis*) from the Seychelles is likewise in the habit of carrying its young on its back, but in this case the purpose of the arrangement is not to transport them from one pool to another, but merely to protect them during development, which takes place on land, the tadpoles breathing by means of lungs.

The Coqui frog (*Hylodes martinicensis*) of the West Indies affords, however, the best instance of the manner in which these reptiles can develop without resorting to the water at all. In this species the eggs are laid on the leaves of plants in damp situations, the female parent remaining near by on guard until they hatch. This takes place in about a fortnight after deposition, but instead of tadpoles, perfect little frogs make their appearance in the world, all the transformations taking place within the egg. A Peruvian species of the same genus (*Hylodes lineatus*) exhibits a precisely similar mode of development; and the same is the case with the curious Solomon Island frog (*Rana opisthodon*).

In conclusion, mention must be made of the tadpole of a South African frog (*Dactylethra capensis*), not on account of any peculiarity in its mode of development, nor on account of its form (although this is strange enough), but from the curious circumstance that it alone, among

all the numerous representatives of its tribe, feeds on animal instead of vegetable substances. The full-grown frog, too, has peculiar ways of its own, never when at rest assuming the sitting posture characteristic of all other frogs and toads, and never showing the humped back of other species. Evidently a thorough radical and reformer among frogs.

SCORPIONS AND THEIR ANTIQUITY

To the circumstance that scorpions have their bodies protected by a coat of the hard substance technically known as chitin, the palaeontologist is indebted for a knowledge of their past history and extreme antiquity; and it is owing to the preservation of their remains in the Palaeozoic strata of both the Old and New Worlds that we are enabled to explain their present geographical distribution. There are many other groups of invertebrates that we can have little doubt are fully as ancient as scorpions, but which lack a hard external investment, and whose past history is accordingly a blank. One of the most remarkable instances of this is afforded by the peculiar creatures termed *Peripatus*, representatives of which are found in countries as remote from one another as South Africa, New Zealand, Australia, South and Central America, and the West Indies. These animals have much the appearance of caterpillars, being furnished with a pair of simple antennae, and having a large number of short, conical, caterpillar-like feet extending along the whole length of the under-surface of the body, and each terminating in a pair of hooked claws. They breathe by tracheal tubes, after the manner of insects, but instead of these tubes opening by a regular series of apertures along each side of the body, their apertures are scattered in an irregular manner over its whole surface. And it has been considered probable that these animals

are closely related to the ancestral stock of insects, spiders and their allies, and myriapods. This being so, it is evident that *Peripatus* must be an extremely ancient type, and there is a great probability that if their remains were suitable for preservation we should find evidence of their existence in some of the oldest rocks of the northern hemisphere. It has, indeed, been assumed from their present geographical distribution that these, as well as many other types of animals, have always been southern forms, and that their presence in the great southern continents and islands indicates a former union of all the lands of the southern hemisphere. That there was a south equatorial belt of land in Palaeozoic times seems to be pretty evident from certain peculiarities connected with the Carboniferous floras of the northern and southern hemispheres, and it is, therefore, possible that in the case of *Peripatus* such an explanation may be the true one. Since, however, palaeontology teaches us that many ancient types have migrated from their original northern home to find a refuge in the remote parts of the southern continents and islands, it seems more probable that such has also been the case with *Peripatus*. And if we can show that this has been the case with the scorpions, which now attain their maximum development in the more southern portions of the globe, the argument will be strengthened in the case of *Peripatus*.

Belonging to the great group of Arachnida, which includes the spiders, scorpions are especially distinguished by their compressed bodies, and by the sharp separation of the cephalo-thorax from the abdomen, the latter consisting of seven segments, and being followed by six narrower segments, collectively forming the post-abdomen, the last of which is specially modified into the so-called sting. The cephalo-thorax or fore part of the body is covered by a

shield-like carapace, upon the upper surface of which are carried a variable number of simple eyes, one pair of which is larger than the others, and is placed dorsally, while the smaller ones are marginal. The first pair of appendages are modified into short nipping claws, while the jaw-appendages, technically known as maxillary palpi, are greatly enlarged to form the huge pair of pincers carried on each side of the head; and the four pairs of walking legs are supported by the first four segments of the thorax. It is important to add that by means of lung-sacs opening by four pairs of apertures on the sides of the abdomen, scorpions breathe air, and it is accordingly only in rocks of fresh-water origin, or such as were deposited near the shore, that their remains are likely to be preserved.

According to the most recent classification, existing scorpions are divided into four families, of which the first two are again divided into several sub-families. An important feature in this classification are the so-called "pedal spurs," which are found upon the articular membrane connecting the foot, or terminal segment of the legs, with the segment that precedes it. The *Scorpionidae*, or typical scorpions, have only one such spur, whereas two are present in the other three families. It will be unnecessary to further consider the classification of the group in this place; but it is important to notice that one of the sub-families of the *Scorpionidae* is confined to Africa south of the Sahara, and the Indian and Malayan countries; while another has representatives not only in those regions, but also in northern South America and Australia. At the present day, indeed, scorpions are found in Europe only in the more southern countries, where the majority of the species are of comparatively small size; and it is in the tropical and sub-tropical regions of the globe that the group attains

its maximum development, the largest forms being, I believe, South American and South African.

In existing kinds of scorpions the median dorsal eye-tubercles are, as a rule, far removed from the front margin of the cephalo-thorax, and thus placed behind the lateral eyes. Apparently the only fossil scorpions agreeing with this group that have been hitherto discovered occur preserved in amber of late Tertiary age; scorpions being quite unknown in lower Tertiary or Secondary rocks. Needless to say that this is not owing to their non-existence in those epochs, but is due either to such rocks being unsuited to the preservation of their remains, or having been deposited far out to sea.

When, however, we reach the Palaeozoic coal-measures, which are mainly of fresh-water origin, and, therefore, just where we should expect to find such creatures, remains of scorpions have been met with both in Europe and North America, some of the species attaining very considerable dimensions. Both in these Carboniferous scorpions and also in certain still older ones from the Silurian rocks, the eye-tubercles are placed either on the actual front margin of the cephalo-thorax, or only a short distance behind it; and they are thus regarded as forming a group apart from the modern scorpions. In the Carboniferous genus *Clythophthalmus*, the median eye-tubercles are immense, and occupy almost the entire front half of the cephalo-thorax; the lateral eyes forming a semicircle behind and to the sides of the larger ones. The maxillary palpi form pincers proportionately as large as in the modern forms, while the legs have similar double claws. The genus *Eoscorpius*, which is likewise common to the Carboniferous rocks of both halves of the northern hemispheres, has all the general features of the preceding, with the exception that the arrangement

of the eyes is different; while *Proscorpius*, of the upper Silurian rocks of North America, is also of the same general type. With *Palaeophonus* of the Silurian of Scotland and Gotland, we reach, however, a more primitive type, in which the walking-legs gradually taper to thin extremities, terminating in simple claws or points, although the palpi still form large pincers.

Such is the palaeontological history of scorpions; and very remarkable history it is, seeing that most of the Palaeozoic types are almost as highly specialised as their existing descendants, and thus show that we should have to go much farther back before we reached the ancestral type. With the exception of certain cockroach-like insects, which occur in the middle Silurian, the scorpions are indeed the oldest land animals, and are therefore entitled, in spite of their unpleasant propensities, to our utmost respect.

We have said that in Palaeozoic times there existed a south equatorial land-girdle, distinguished from the land of the northern hemisphere (from which it was probably isolated) by the peculiar character of its flora; and as the Palaeozoic scorpions inhabited the northern land, it is scarcely likely that they were also found in the southern zone. During the Secondary epoch the latter zone appears to have been split up, and the continental areas consequently assumed some approach to their present configuration. The descendants of the ancient Palaeozoic scorpions began soon after, in all probability, to migrate southwards, along the different lines of communication; and we thus can readily understand why some of the existing sub-families are represented in such widely separated areas as India, Africa, South America, and Australia, without resorting to any comparatively recent connection between these countries.

If such an explanation holds good in the case of the scorpions, there is no reason why it should not be equally valid in the instance of *Peripatus*. It may be objected that whereas in the case of the scorpions we have only *sub-families* which occur over such widely sundered areas, in *Peripatus* we have one and the same genus.* The objection would, however, be equally valid if we assumed that genus to have attained its present geographical distribution by the aid of a southern belt of land, seeing that there is no evidence that such belt has existed since the end of the Palaeozoic or the commencement of the Secondary epoch.†

Although not coming strictly within the scope of its title, this article may be concluded by a brief reference to some of the habits of scorpions. All scorpions are nocturnal and somewhat sluggish creatures; but while some species in which the tail is light carry it stretched nearly straight out behind, those in which it is heavier habitually curve it over the back; and those forms in which the appendage is carried in the latter manner are further distinguished by raising their bodies much higher on the legs than is the case with the others. Some kinds, again, when walking, carry their large pincers stuck out in front of the head to act as feelers. All scorpions are carnivorous, while many of them, in spite of their sluggish appearance, are able to capture and kill such alert creatures as cockroaches. Mr. Pocock, who has kept scorpions in captivity, writes that "as soon as a cockroach is seized, the use of the scorpion's tail is seen, for this organ is brought rapidly over the latter's back, and the point of the sting thrust into the

* By some writers *Peripatus* is split into distinct genera.

† There are objections to the theory of an Antarctic continent uniting South America, Africa, and Australia, having existed in Tertiary times.

insect. The poison instilled into the wound thus made, although not causing immediate death, has a paralysing effect upon the muscles, and quickly deprives the insect of struggling powers, and consequently of all chance of escape. If the insect is a small one—one in fact that can be easily held in the pincers and eaten without trouble while alive—a scorpion does not always waste poison upon it. Thus I have seen a *Parabuthus* (one of the genera of scorpions) seize a bluebottle fly, transfer it straight to its mandibles, and pick it to pieces with them while still kicking. . . . An insect is literally picked to pieces by the small chelate mandibles, these two jaws being thrust out and retracted alternately, first one and then the other being used; the soft juices and tissues thus exposed being drawn into the minute mouth by the sucking action of the stomach."

Old fables die hard, and none is more persistent than the legend that the scorpion, when surrounded by a ring of fire, puts an end to its existence by turning its tail over its back and stinging itself to death. No matter that naturalists have proved that their poison is innocuous to their own kind, and that scorpions are killed by a very moderate elevation of temperature, the old, old story is still as firmly believed as ever by the general public.

In an article published in the ninth edition of the "Encyclopaedia Britannica," the Rev. O. P. Cambridge refused to believe that there was any substratum of fact in the popular legend, but Mr. Pocock, writing in *Nature* for 1893, is more merciful. He thinks, indeed, that a scorpion may occasionally sting itself, either by a random blow for an unseen enemy, or when it has been irritated by the contact of any strong stimulant, such as acid or mustard, or even that in the madness of pain it may be driven to turn its weapon on itself; but that in any case there is an

intention of causing its own death cannot for a moment be admitted.

Although, probably, many of my readers are acquainted with it, for the benefit of those who are not I must conclude with a well-known Indian story. Where scorpions and centipedes abound, it is the general custom of servants in India to turn their masters' boots upside down before helping to put them on. In the instance in question, where this precaution had been omitted, a cavalry officer had just put his foot into a regulation boot, when he felt something sharp touch his heel. With the greatest promptitude he lifted his leg and stamped violently on the ground, in the hope of destroying the supposed scorpion before it had time to use its sting. He found that a spur, with the rowels uppermost, had been inadvertently dropped into the boot!

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